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ABSTRACT

Admissions procedures were examined at ten selected medical schools, between 1973 and 1975, with particular interest in comparing the procedures for minority and majority medical school applicants. An affirmative action policy was found to be operational in each of the schools, which took special pains to evaluate minority and disadvantaged students in a manner different from the common procedures for majority applicants. These policies significantly improved minority applicants' chances of admission. Although the schools differed in the weighting of students' credentials for admission, certain characteristics were generally important--undergraduate achievement in science courses, residence in the state, and undergraduate enrollment in the parent university. Although the science subtest scores on the Medical College Admission Test (MCAT) were important for all applicants, the general quantitative and verbal MCAT scores seemed to be scarcely used in evaluating minority students. Further analysis, using the new edition of the MCAT, is recommended. (Author/GDC)

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FACTORS AFFECTING MEDICAL SCHOOL ADMISSION DECISIONS FOR MINORITY AND MAJORITY APPLICANTS: A COMPARATIVE STUDY OF TEN SCHOOLS

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PREFACE

The research in this report was conducted under contract to the Division of Medicine, Health Resources Administration, Department of Health, Education, and Welfare (Contract No. HRA-231-75-0614). The primary objective of the report is to analyze the admissions processes of a representative group of U.S. medical schools, particularly as they pertain to affirmative action policies for minority applicants. Data on all applicants to each of the ten medical schools for the classes of 1973 through 1975 have been analyzed to assess how admissions boards weight various applicant characteristics to decide which applicants will be admitted. We separately analyzed admissions decisions for majority and minority applicants for each school and examined the implications of affirmative action programs for minority access to medical education.

The results of this research should be useful to anyone interested in the medical school admissions process, including federal and state officials concerned with health policy, prospective medical students, medical school faculty, administrators, and students. The methodology in the report may also be useful to those concerned with applications of statistical data analysis to public policy issues.

This report is one of a series of three related studies dealing with medical school admissions and performance. The other two reports are:

John E. Rolph, Albert P. Williams, A. Lee Laniear, with the assistance of Wendy D. Cooper, *Predicting Minority and Majority Medical Student Performance on the National Board Exams*, R-2029-HEW, November 1978.

John E. Rolph, Albert P. Williams, and Carolyn L. Lee, *The Effect of State of Residence on Medical School Admissions*, R-2014-HEW, February 1978.

SUMMARY

The research described in this report is an outgrowth of earlier analysis of the medical school admissions process, which focused on federal program effects. In this earlier work we learned that many diverse factors affect medical school admissions and that admissions processes differ across schools and change over time.

In this study we examine the processes of ten medical schools over the three years 1973 through 1975; our particular concern is to compare the admissions processes for majority and minority applicants at these schools. Because the schools were chosen to represent all U.S. medical schools, the analysis should provide a sound basis for generalizations about U.S. medical school admissions processes and the effects of affirmative action programs on the access of minority groups to medical careers.

A number of important trends can be observed in recent national data on medical school admissions:

- The number of first year medical school places increased by 70 percent in the last decade, but applicants outstripped them by 117 percent.
- Total applications to medical schools increased fourfold as applicants applied to more schools in the hopes of being admitted to one.
- The average quality of accepted applicants improved in terms of undergraduate grade point averages (GPA) and Medical College Admissions Test (MCAT) scores.
- Both private and public medical schools increasingly restricted their first year classes to home state applicants.
- The number of women applicants, enrollees, and graduates rose sharply.
- Affirmative action programs greatly increased access to medical education for minority groups--particularly

Blacks, American Indians, Mexican-Americans and Puerto Ricans.

The effects of these recent trends has been to complicate the work of medical school admissions committees, who must generally screen 20 to 30 applicants for each vacancy. Their task is to select from a large pool those applicants who will become the best physicians, but there is no clear answer to the question, "Best for what?" Different medical schools emphasize different aspects of medical training and service goals, although all medical schools seek to achieve some "balance" of student types in each class.

Even if a medical school could establish clearly what kinds of physicians it wished to produce, it would find few measures of physician performance with which it could evaluate its selectivity in admissions or the content of its curriculum. Although researchers on medical education have produced a voluminous literature, efforts to establish measures of educational achievement that are valid measures of physician performance are both scarce and deficient.

A review of the literature shows that MCATs and undergraduate school grades are the most widely used and most reliable predictors of medical student performance on such measures as grades, National Board scores, rank in class, graduation, etc. Data on the amount of course work, the quality of the undergraduate school attended, sex, and other demographic data have also been used in analyses of performance. However, with a few exceptions, small sample sizes--usually data from one school--and the failure to use modern multivariate statistical techniques have hampered these analyses.

Research on noncognitive--generally more subjective--predictors of performance has produced even more limited results. Notwithstanding the difficulties in ascertaining the validity of the preadmissions interview, most medical school admissions committees continue to place heavy reliance on it in deciding among candidates. The efforts to use the interview as a source of noncognitive data on applicants is understandable, because the low attrition rate in medical schools proves that admissions committees can with high

confidence select applicants who have the cognitive skills required in medical school. They are more concerned with, but much less confident of, their ability to identify characteristics of applicants that will make them conscientious and effective providers of care.

The growth in enrollment of minority medical students in predominantly white schools is a phenomenon of the past decade. To provide these opportunities for minorities has required medical schools to relax the criteria used to select majority candidates, an action that is central to the concept of affirmative action. As academic medicine fell short of its affirmative action goals and minority students experienced difficulty with the medical school curriculum, efforts were made to expand and improve the quality of the minority applicant pool.

Research on predictors of minority performance began as more data on affirmative action programs became available. However, the small numbers of minority students at any one school have limited most studies to the use of simple analytic methods. Admissions committees have therefore had little analytic basis for deciding how to relax admissions standards for minority applicants without risking substantially increased attrition rates.

Rejected majority applicants have challenged the legality of schools' selecting nominally inferior minority applicants under the aegis of affirmative action. The Bakke decision by the U.S. Supreme Court confirmed the legality of most medical schools' affirmative action programs but explicitly ruled against the use of strict quotas for admitting minority applicants, regardless of their qualifications.

Although there is some evidence to support claims that medical schools discriminated against women applicants during the 1950s and 1960s, there is no evidence of such discrimination in recent years. During the 1970s women have applied to medical schools in steadily increasing numbers, have been admitted, and have performed on a par with men. Larger proportions of female than male applicants have been admitted in recent years, and multivariate statistical analyses indicate that women applicants have slightly better chances of being

admitted than comparable males. However, the medical profession will remain predominantly male for the foreseeable future because only about a third as many women as men apply.

In the empirical part of this report, we estimate the relative weights that admissions committees at the ten sample schools gave to various attributes (GPA, MCAT, state of residence, and so on) in deciding which applicants to admit from those who applied in a particular year. Conditional maximum likelihood logistic regression is the multivariate statistical method used to estimate the admissions equations that contain these weights (regression coefficients). The equations provide estimates of an applicant's probability of being admitted to the particular school as a function of his or her characteristics. The data on each individual applicant's characteristics and the information on whether the applicant was or was not admitted to the particular school was obtained from the American Medical College Application Service (AMCAS).

Separate admissions equations are estimated for each year (1973, 1974, 1975) for majority applicants at each of the ten schools (30 equations). Because of the small numbers of applicants, we estimated a single equation for minority applicants for all three years at each of the ten schools, but we did estimate year-to-year changes (10 equations).

The estimated equations for majority admissions show that grades in undergraduate science courses were weighted heavily in admissions decisions at all schools, and most schools also gave significant though lesser weight to grades in non-science courses. Although grades matter a great deal, applicants with more total units of coursework were not favored, except that schools tended not to favor applicants who applied to be admitted without completing all undergraduate coursework. Applicants with graduate school coursework appear to have been treated no differently than others.

The *Science MCAT* was the most important of the standardized test scores used to evaluate majority applicants, but the importance of this test varied considerably across schools. The *Verbal and Quantitative MCATs* were generally given significant but somewhat less

weight than the *Science MCAT*. The *General Information* component was almost always accorded the least weight among the MCATs.

Nine of the ten schools favor majority applicants who graduated from the undergraduate school of the parent university, although the amount of preference accorded varies sharply across medical schools. Not surprisingly, admissions committees tend to favor applicants from more selective undergraduate schools.

Being a home state resident greatly improves a majority applicant's chances of admission at all ten schools, and some private medical schools give greater preferences to home state applicants than some public medical schools. Two of the public schools in our sample have agreements whereby they give preference to applicants from particular neighboring states, and our analysis shows the effects of these preferences to be quite significant.

There is no evidence of discrimination against female applicants in any of the ten schools; if anything, female applicants appeared to be favored over otherwise comparable males at most of the schools. By and large, Asian-American applicants, who are included in the majority analysis, appear to be evaluated no differently than Caucasian or "white" applicants.

There are several reasons to expect minority admissions equations to differ from the majority equations: (1) Data on the national minority applicant pool show their average scores to be well below majority averages; (2) medical school experience in evaluating minority applicants is recent and limited; (3) there are many fewer minority than majority applicants, which could be expected to decrease the predictive power of minority equations; and (4) the purpose of affirmative action is to find evidence of minority applicants' suitability for the medical profession that is not reflected in the premedical characteristics used to evaluate majority applicants.

The minority admissions equations differ from the majority equations in ways that are consistent with our expectations. Undergraduate science grades and Science MCAT scores were, in general, heavily weighted in minority admissions decisions at all ten schools. Although several schools apparently experimented with minority

admissions criteria that did not emphasize achievement in science, these experiments were generally abandoned by 1975.

Besides the two measures of science achievement, admissions decisions reflect no strong and consistent weighting of cognitive measures of minority preparation for medical school. Minority applicants with better Verbal MCAT scores appear to have been somewhat preferred, but these may have been proxies for verbal skills that showed up in the interview. Neither the Quantitative MCAT nor the General MCAT was evaluated in any consistent manner.

The strong preferences for minority applicants from the same undergraduate school were similar to those observed in the majority equations. Minority applicants from more selective undergraduate schools were also favored, as were their majority counterparts.

The form of our analysis limits the inferences that can be made regarding changes in minority admissions processes over time. However, there are strong indications that most schools in our sample raised their standards for minority admissions over the three year period and that they increasingly relied upon more conventional measures of preparation for medical school.

Simple comparisons of summary data for admitted majority and minority applicants provide clear evidence of strong affirmative action efforts by our sample medical schools. Comparisons of the equations for majority and minority admissions processes indicate further that the schools differentially relaxed specific admissions criteria for minorities in efforts to compensate for particular ways in which they were believed to be "disadvantaged."

The most striking evidence of strong affirmative action programs comes from comparisons between estimates of the probabilities of admission for hypothetical candidates using minority and majority equations. Minority applicants with better than a 50-50 chance of admission when evaluated by the minority process would rarely have had better than a 1 in 20 chance of admission if evaluated by the same standards as majority applicants.

ACKNOWLEDGMENTS

This research would not have been possible without the trust and active cooperation of the ten medical schools in our sample. Admissions deans at these medical schools patiently explained admissions procedures and gave us access to administrative personnel in their offices who screen and manage the enormous volume of material in individual applications. Admissions committees permitted us to observe their decision processes so that we could gain first-hand understanding of the deliberative process.

The active cooperation of the Association of American Medical Colleges (AAMC) has been vital to the conduct of our research, and we particularly benefited from the counsel and encouragement of John A. D. Cooper, its President, and August G. Swanson, its Director of Academic Affairs. Gerald Kurtz helped us greatly in the use of data from the American Medical College Application Service.

Throughout the course of this study, our interactions with Joseph M. Brown, project officer for this contract, have been helpful and pleasant. Rand colleague John E. Rolph provided helpful advice on the statistical analysis and on the nontechnical description of maximum likelihood logistic regression methods. The report benefited substantially from the comments and criticisms of Deborah Hensler and Winston Chow, and from the editorial assistance of Helen Turin. Of course we bear full responsibility for any remaining errors of commission or omission.

CONTENTS

PREFACE..... iii

SUMMARY..... v

ACKNOWLEDGMENTS..... xi

TABLES..... xv

Section

I. INTRODUCTION..... 1
Recent Trends in Medical School Admissions..... 2
The Focus and Organization of This Report..... 8

II. THE LITERATURE ON MEDICAL SCHOOL ADMISSIONS AND PERFORMANCE..... 11
Prediction of Performance..... 12
Affirmative Action..... 20

III. METHODOLOGY..... 31
Model Estimation Procedures..... 32
Data..... 35

IV. ANALYSIS OF MAJORITY AND MINORITY ADMISSIONS DECISIONS.... 42
Majority Admissions..... 42
Minority Admissions..... 54
Comparisons of Majority and Minority Admissions Processes..... 62

V. CONCLUSIONS..... 70

Appendix

A. SELECTING SCHOOLS FOR A STUDY OF ACADEMIC MEDICAL CENTERS..... 75

B. SUMMARY STATISTICS FOR APPLICANTS FOR TEN MEDICAL SCHOOLS, 1973, 1974, 1975..... 81

BIBLIOGRAPHY..... 88

TABLES

1. Students and Graduates in Medical and Basic Science Schools, 1965-1978..... 3
2. Medical School Application Activity..... 4
3. Distribution of First-year Medical Students by Undergraduate Grade Point Average..... 5
4. Mean Medical College Admissions Test Scores of Accepted Applicants..... 6
5. Women in U.S. Medical Schools..... 7
6. Number and Percent of State Residents Enrolled in First-year Class by Public and Private Medical Schools, 1969-1977. 8
7. First-year Minority Student Enrollment in U.S. Medical Schools..... 9
8. Scale for Undergraduate School Selectivity..... 38
9. Estimated Admissions Equations for Majority Medical School Applicants at Ten Medical Schools, 1973..... 43
10. Estimated Admissions Equations for Majority Medical School Applicants at Ten Medical Schools, 1974..... 44
11. Estimated Admissions Equations for Majority Medical School Applicants at Ten Medical Schools, 1975..... 45
12. The Effect of Being a Home State Applicant and Attending the Same Undergraduate School on Admissions Probabilities for Hypothetical Majority Candidates..... 50
13. The Effect of Interstate Agreement on Majority Admissions Processes of Two Public Medical Schools..... 53
14. Estimated Admissions Equations for Minority Medical School Applicants at Ten Schools, 1973 Through 1975..... 56
15. The Effect of Being a Home State Applicant and Attending the Same Undergraduate School on Admissions Probabilities for Hypothetical Minority Candidates..... 59
16. Comparison of Admissions Probabilities for Hypothetical Minority and Majority Applicants when Evaluated According to Minority and Majority Equations--Home State Residents.... 65
17. Comparison of Admissions Probabilities for Hypothetical Minority and Majority Applicants when Evaluated According to Minority and Majority Equations--Nonresidents..... 67

A.1. Variables Used in Factor Analysis..... 76

A.2. Six Factors Describing Academic Health Centers..... 78

A.3. Ten Clusters on Six Factors..... 80

B.1. Mean and Standard Deviations, Majority, 1973..... 82
B.2. Mean and Standard Deviations, Majority, 1974..... 83
B.3. Mean and Standard Deviations, Majority, 1975..... 84
B.4. Mean and Standard Deviations, Minority, 1973..... 85
B.5. Mean and Standard Deviations, Minority, 1974..... 86
B.6. Mean and Standard Deviations, Minority, 1975..... 87

I. INTRODUCTION

The research described in this report is an outgrowth of our earlier analysis of the medical school admissions process,[1] which was, in turn, part of a larger study of the effects of federal programs on academic medical centers. Although the larger study as well as the admissions part of the analysis emphasized federal program effects, we learned from that work that a broad range of factors impinge on admissions decisions beyond those with which the federal government is actively concerned. We also learned that medical school admissions policy is not at all static and that important changes often occur over a period of several years and sometimes between two successive years.

Our purpose here is to examine changes in the admissions processes over time and across medical schools, particularly as they pertain to affirmative action. The subjects of our analysis are ten medical schools whose processes were analyzed in the earlier study, and the empirical portion of this report compares the majority and minority admissions processes. Our observations of the admissions process at these schools and our analysis of data on their applicants for admission are the main bases for our generalizations about the medical school admissions process in the earlier study. Their data are the grist for the analysis in this study, and our impressions regarding the dynamics of their processes have been important in focusing the analysis described here.

The ten sample schools were selected to be broadly representative of the population of 94 U.S. medical schools granting M.D. degrees in 1972. There were 111 such schools by 1978. In our selection process we attempted to take account of a number of characteristics on which schools differ. These included size, state versus private ownership, degree of research emphasis, involvement in other health education programs, reliance on federal financial support, region of the country, and so on. We believe that the resulting sample is a reasonable compromise between representativeness and

economy. See Appendix A for a brief description of the selection process

Most of the readers of this report will not need to be convinced of the importance of the medical school admissions process. Very simply, it is by far the most important factor determining who will be the country's future physicians. Only a little more than a third of those who apply to U.S. medical schools are admitted, but more than 95 percent of those who are admitted become physicians. Although attrition rates are higher among minority students admitted through affirmative action programs, the admissions process is still the overwhelmingly important determinant of the minority physician population. Over 80 percent of minority entrants will receive their M.D. degrees.

RECENT TRENDS IN MEDICAL SCHOOL ADMISSIONS

In recent years, several significant changes have profoundly affected access to medical education. The number of places in medical schools has grown rapidly in the last decade (see Table 1). We believe that federal government programs were instrumental in this growth, but other forces were also at work.[2] Whatever the source of influence, arguments for expanding medical education facilities had a common theme, which was to eliminate a national or local physician shortage. This growth of medical school places was outstripped by the growth in the number of applicants. Table 2 shows that the applicants per place ratio rose from 2.1:1 in 1965 to 2.8:1 in 1975 before leveling off, a fourfold increase in the number of medical school applications in a decade.

As the competition for medical school places increased, applicants began to apply to more schools in the hope of increasing their chances of acceptance at at least one school. Table 2 also shows the increase in applications per individual. The cost to the schools and applicants of the admissions process grew with the increase in applications, personal interviews, and decisions.

Although the rise in the ratio of applicants to places does not necessarily improve the quality of the entering medical school classes, admissions deans generally feel that quality has improved.

Table 1

STUDENTS AND GRADUATES IN MEDICAL AND BASIC SCIFNCE SCHOOLS, 1965-1978

Academic Year	Number of Schools	Total Enrollment	First-Year Students	Graduates
1965	88	32,835	8,759	7,574
1966	89	33,423	8,964	7,743
1967	94	34,538	9,479	7,973
1968	99	35,833	9,863	8,059
1969	101	37,669	10,401	8,367
1970	103	40,487	11,348	8,974
1971	108	43,650	12,361	9,551
1972	112	47,546	13,726	10,391
1973	114	50,886	14,185	11,613
1974	114	54,074	14,963	12,714
1975	114	56,244	15,351	13,561
1976	116	58,266	15,667	13,607
1977	122	60,456	16,134	14,393

SOURCE: *Journal of the American Medical Association*, December 22/29, 1978, p. 2822.

The best evidence in the public domain on this matter is the trend in grade point averages of admitted applicants. Table 3 shows the trend in the distribution of accepted applicants by GPA over time. Table 4 shows a similar trend of improving scores on the Medical College Admission Test (MCAT) of admitted applicants. The general information subtest (which measures an applicant's knowledge of history, culture, and current events) is the only component of the MCAT for which scores have not consistently improved. These data tend to support the widely held view that at least the academic quality of admitted applicants has improved.

In the late 1960s, there was growing social concern over the small number of women who applied and were admitted to U.S. medical schools. Public policymakers indicated their interests in increasing

Table 2

MEDICAL SCHOOL APPLICATION ACTIVITY

First-Year Class	Applicants	Total Number of Applications	Applications per Individual	Accepted Applicants	Applicants/Acceptance Ratio	First-Year Enrollment
1965	18,703	87,111	4.7	9,012	2.1	8,759
1966	18,250	87,627	4.8	9,123	2.0	8,964
1967	18,724	93,332	5.0	9,702	1.9	9,479
1968	21,118	112,195	5.2	10,092	2.1	9,863
1969	24,465	133,822	5.5	10,547	2.3	10,401
1970	24,987	148,797	6.0	11,500	2.2	11,348
1971	29,172	210,943	7.2	12,335	2.4	12,361
1972	36,135	267,306	7.4	13,757	2.6	13,726
1973	40,506	328,275	8.1	14,335	2.8	14,185
1974	42,624	362,374	8.5	15,066	2.8	14,963
1975	42,303	366,040	8.7	15,365	2.8	15,351
1976	42,155	372,282	8.8	15,774	2.7	15,667
1977	40,569	371,545	9.2	15,977	2.5	16,134

SOURCE: *JAMA*, December 22/29, 1978, p. 2822, based on information from Association of American Medical Colleges.

Table 3

DISTRIBUTION OF FIRST-YEAR MEDICAL STUDENTS BY UNDERGRADUATE GRADE POINT AVERAGE

Year	A Average (3.6 to 4.0)	B Average (2.6 to 3.5)	C Average (< 2.6)	Unknown
1965	12.7	76.7	10.6	
1966	13.6	77.8	8.6	
1967	14.1	76.8	9.1	
1968	16.8	75.9	7.3	
1969	17.9	76.6	5.5	
1970	19.7	73.3	7.0	
1971	24.0	70.0	6.0	
1972	28.9	60.1	4.5	6.5
1973	33.9	54.7	4.5	6.9
1974	39.3	50.8	3.0	6.8
1975	44.2	47.4	2.4	6.0
1976	46.0	47.3	2.7	4.0
1977	50.4	43.0	1.6	5.0

SOURCE: *JAMA*, December 22/29, 1978, p. 2823.

the representation of women within the health professions, and in 1970 the Association of American Medical Colleges issued a "Resolution on Equal Opportunity."[3] Many factors doubtless contributed to the under-representation of women in medicine, and there is disagreement over their relative importance. However, the numbers in Table 5 speak for themselves; the enrollment of women has grown sharply in the 1970s.

Another recent trend in medical education admissions has been the growing proportion of students who enroll in a medical school located in their home state. Table 6 shows this trend toward enrollment in a home state school appears in both public and private medical schools. A range of explanations can be offered for this trend, ranging from state political considerations, to physician shortage concerns, to changes in the pattern of applications.[4]

Table 4

MEAN MEDICAL COLLEGE ADMISSIONS TEST SCORES
OF ACCEPTED APPLICANTS

Year	Verbal Ability	Quantitative Ability	General Information	Science
1965	541	583	565	549
1966	549	585	566	550
1967	554	596	566	565
1968	558	600	570	577
1969	582	603	569	577
1970	559	606	560	558
1971	560	606	556	565
1972	562	614	555	575
1973	567	609	563	592
1974	563	611	559	603
1975	575	620	550	615
1976	573	633	549	618
1977	580	633	559	639

SOURCE: *JAMA*, December 22/29, 1978, p. 2824, based on information from Association of American Medical Colleges.

The last and perhaps most significant change in medical school admissions policies has been the emphasis on affirmative action programs for minorities. During the 1950s and 1960s, well over half of black medical students were enrolled in two predominantly black medical schools, Howard and Meharry. By 1970, these schools accounted for only about one third of black enrollment. Table 7 shows changes in first year enrollment of different minority groups over time. This increase was brought about by changes in medical school admissions programs that gave significant preference to minority applicants. We analyze the nature and degree of these preferences in Section IV below.

Table 5

WOMEN IN U.S. MEDICAL SCHOOLS

Year	Women Applicants		Women in Entering Class		Total Women Enrolled		Women Graduates	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1965	1,731	9.0	788	8.9	2,503	7.7	503	6.8
1969	2,289	9.4	952	9.2	3,390	9.0	700	8.4
1970	2,734	10.9	1,256	11.1	3,894	9.6	827	9.2
1971	3,737	12.8	1,693	13.7	4,755	10.9	860	9.0
1972	5,480	15.2	2,315	16.9	6,099	12.8	924	8.9
1973	7,202	17.8	2,743	19.6	7,731	15.4	1,264	11.1
1974	8,712	20.4	3,260	22.3	9,786	18.1	1,706	13.4
1975	9,575	22.6	3,656	23.8	11,527	20.5	2,200	16.2
1976	10,244	24.3	3,876	24.7	13,059	22.4	2,611	19.2
1977	10,195	25.1	4,149	25.7	14,373	23.8	3,086	21.4

SOURCE: *JAMA*, December 22/29, 1978, p. 2823, based on information from Association of American Medical Colleges.

Table 6

NUMBER AND PERCENT OF STATE RESIDENTS ENROLLED IN FIRST-YEAR CLASS BY PUBLIC AND PRIVATE MEDICAL SCHOOLS, 1969-1977

	Public Schools		Private Schools		All Schools	
Year	Number	Percent	Number	Percent	Number	Percent
1969	4,935	86	1,984	43	6,919	66
1970	5,466	87	2,286	45	7,752	68
1971	6,011	88	2,595	47	8,608	70
1972	6,676	89	2,997	50	9,678	72
1973	7,082	90	3,080	51	10,162	73
1974	7,778	93	3,143	51	10,921	76
1975	8,135	93	3,325	52	11,460	76
1976	8,233	91	3,288	52	11,521	75
1977	9,031	93	3,430	53	12,461	77

SOURCE: *JAMA*, December 22/29, 1978, p. 2823.

THE FOCUS AND ORGANIZATION OF THIS REPORT

This report focuses on the effects of medical school applicants' quantifiable characteristics on their chances of being admitted to particular medical schools. The quantifiable characteristics include such measures of academic preparation as MCAT scores and undergraduate GPA as well as categorical variables such as state of residence, sex, and junior status at time of application.

We recognize that admissions decisions are not made solely--perhaps not even largely--on the basis of these readily quantifiable characteristics of applicants. Almost all schools ask applicants who get beyond initial screeening to submit a personal statement of purpose and to provide the names of individuals who will write confidential letters of recommendation to support their candidacy. At most schools, applicants are rarely admitted without undergoing a personal interview by representatives of the school. As important as these subjective assessments may be, we have neither the data nor the methods required to assess their effects on admissions decisions.

Table 7

FIRST-YEAR MINORITY STUDENT ENROLLMENT IN U.S. MEDICAL SCHOOLS

Year	Black		American Indian Alaskan Native		Mexican-American		Puerto Rican		Other Hispanic		Asian or Pacific Islander	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1969[a]	649	4.3	5	0.1	45	0.4	11	0.1	--[c]	--[c]	--[c]	--[c]
1970	708[a]	6.2	--[c]	--[c]	--[c]	--[c]	--[c]	--[c]	--[c]	--[c]	--[c]	--[c]
1971	890	7.2	21	--[c]	117	--[c]	33	--[c]	--[c]	--[c]	--[c]	--[c]
1972	858	6.4	33	0.2	151	1.1	44	0.3	--[c]	--[c]	--[c]	--[c]
1973	870	6.4	33	0.2	170	1.2	48	0.3	--[c]	--[c]	--[c]	--[c]
1974	950	6.5	70	0.5	196	1.4	63	0.4	--[c]	--[c]	--[c]	--[c]
1975	893	5.9	57	0.4	207	1.4	70	0.5	--[c]	--[c]	--[c]	--[c]
1976	935	6.0	41	0.3	239	1.5	76	0.5	--[c]	--[c]	--[c]	--[c]
1977[b]	959	6.0	46	0.3	216	1.3	229	1.4	164	1.0	418	2.6

SOURCES: Various issues of *Journal of the American Medical Association*, year-end education issue.

[a] Includes students repeating the first year. All other data on first year students excludes repeaters.

[b] Data for 1977 are not strictly comparable to those of previous years due to the addition of new categories and the inclusion of data from the University of Puerto Rico.

[c] Unknown.

-9-

The remainder of this report is organized into four sections. Section II describes the general literature on how medical schools evaluate objective characteristics of applicants and how those characteristics are related to various measures of performance. This section also reviews literature on affirmative action programs for underrepresented minority groups and women. Section III describes the statistical methods used to estimate equations for the probability of admission to medical schools and the data that are used as explanatory variables to these equations. Section IV describes the results of separate analyses for majority and minority applicants at the ten schools we studied; it then contrasts the majority and minority admissions processes. The final section contains a discussion of more general implications of our analysis.

Notes to Sec. I

[1]Carter et al. (1974), pp. 21-31.

[2]Ibid., pp. 17-19.

[3]The text of the resolution is presented in Association of American Medical Colleges (1978), p. 9.

[4]The implications of this trend for applicants from different states is the subject of another report in this series, Rolph, Williams, and Lee (1978). The effect of being a home state applicant on chances of being admitted to a particular medical school is analyzed below.

II. THE LITERATURE ON MEDICAL SCHOOL ADMISSIONS AND PERFORMANCE

Each year medical school admissions committees attempt to select the "best" applicants from the large pool of those who apply. This generally means screening 20 to 30 applicants for each vacancy. The decision process is painstaking and expensive for the schools. For the applicants, it is a major determinant of professional future.

The major problem of the admissions process (aside from the sheer logistics of processing applications and interviewing applicants) is to establish criteria for selecting the best applicants. This is made particularly difficult because there is no simple answer to the question, "Best for what?" Different medical schools emphasize different aspects of medical training. Some stress the highly scientific aspects of medicine and seek to find applicants interested in pursuing academic or research careers. Others emphasize training in primary care and seek applicants dedicated to clinical practice. As a practical matter, the emphasis of the school only affects the proportions of students within broad categories of career objectives because almost every school wants to achieve some "balance" of student types in each medical school class.

Even if a medical school could establish clearly what kinds of physicians it wishes to produce, it would find few measures of physician performance to evaluate admissions and educational processes.[1] There are certainly reliable measures of physician knowledge at various points in the educational continuum, but little has been done to establish the validity of these measures as indicators of the quality of care a physician actually provides.

Despite the uncertainty regarding validity, measures of medical knowledge and educational achievement are widely used by academic medicine to evaluate individual students as well as their admissions decisions and educational programs. These evaluations constitute much of the research in medical education.

Another large category of medical education research attempts to determine the factors that explain admissions decisions. It takes as given the assumed relationships between preadmission characteristics and medical student or physician performance.

In this brief review of literature, we examine both categories of research, although this report per se belongs in the second category. The performance literature is important to the admissions process because it and the subjective assessments of admissions committee members provide the bases for admissions decisions. Our review of the admissions literature will first examine general studies and then the recent literature on affirmative action admissions.[2]

PREDICTION OF PERFORMANCE

Analysis to predict performance of medical students has been hampered by several problems. We have already outlined the general problems of determining valid performance criteria, but researchers in the field have generally been willing to use admittedly limited performance measures in their analysis. One important problem has been the size of the population for analysis--usually one or two classes from a single medical school or no more than several medical schools. Another has been access to longitudinal data on performance: few researchers have had data series going beyond medical school.

There are dozens of journal articles describing correlations between preadmission characteristics and some measure of medical student performance. Most of the performance measures come from the records of individual medical schools as do the preadmission characteristics. The performance measures include graduation (or attrition) from medical school, grades, rank in class, faculty rating (e.g., evaluations during clinical clerkships), scores on Parts I and II of the tests administered by the National Board of Medical Examiners (NBME), and so on. The most common form of statistical analysis used is the simple correlation. There are few attempts to develop multivariate models such as that by Woodward (1968) to predict performance, even though admissions committees consider multiple applicant characteristics simultaneously.

Because the Medical College Admission Test (MCAT) is a standardized test required by almost all medical schools, it is probably the most common test instrument used in research on the prediction of performance.[3] In their review of literature on the MCAT, Cuca, Sakakeeny and Johnson (1976) report that many researchers observe correlations in the .35 to .45 range between the MCAT and various performance measures. However, a number of studies have shown much lower correlations.

A number of researchers (Gee, 1958; Schumacher, 1960; Sanazaro and Hutchins, 1963) have identified "restriction on range" of scores as a problem inherent to studies of the relationships between MCAT scores and performance measures; that is, few individuals below the top half of the MCAT range are admitted to medical school.[4] As a consequence, differences in performance must be "explained" by scores within a small part of the MCAT range. Put another way, if information were available on the "performance" of rejected applicants with low MCAT scores, it is reasonable to expect that the predictive reliability of the test would be greater than it is calculated to be using data only from applicants whose scores were high enough to get them into medical school.[5] However, researchers such as Gough, Hall, and Harris (1963) have suggested that the restriction of range effect is small. Sedlacek and Hutchins (1966a, b) attempted to test the "restriction of range" hypothesis using data from a number of schools and found little evidence to support it.

For all of its limitations, the MCAT has had significant predictive power for measures of physician knowledge as far removed from medical school as the specialty certification exams. Bell (1977) found statistically significant ($p < .05$) correlations between scores on all MCAT parts and scores on the American Board of Internal Medicine (ABIM) written exam taken by 438 graduates from the classes of 1955, 1960, 1965, and 1969 from nine medical schools. The restriction of range effect on Bell's study must be assumed to be larger than on studies of medical school performance. Nevertheless, the Science MCAT score was still a significant predictor ($p = .02$) of the certifying exam score after medical school rank in class had been controlled for.

Criticism regarding the MCAT's predictive value has stimulated efforts to clarify its purpose, such as reviews by Sanazaro and Hutchins (1963) and Erdmann et al. (1971). The criticism also helped to stimulate the development of a new MCAT (Littlemeyer, 1976), which was first administered in 1977.

Undergraduate grade point average (GPA) is the other common factor (besides MCAT) used in studies of performance of medical school students and graduates. In their review monograph, Cuca, Sakakeeny, and Johnson (1976) conclude, "The research examining the predictive validity of GPA generally indicates its superiority to the MCAT and to other tests in forecasting medical school performance at whatever point along the continuum." Such a conclusion is intuitively appealing because GPA is a measure of sustained performance over a period of years, and may be reasonably judged to measure academic diligence as well as achievement. By contrast, the MCAT is a one time test of knowledge and aptitude.

The comparison of the simple correlation between GPA and performance measures with those between individual MCAT parts and performance may give a misleading impression of GPA's predictive superiority. The appropriate framework for comparison is a multivariate analysis that uses all MCAT parts, and as we have pointed out there are a few such studies. Gough and Hall (1975b) present multivariate analysis and summary data that permit such a comparison of the predictive power of the MCATs with that of GPA for academic performance in medical school. Their results suggest GPA and the combined MCAT scores are roughly equal in predictive power; MCATs appear superior to GPA for women and vice versa for men.[6] However, in subsequent analysis of this ongoing longitudinal data series, Gough (1978) suggests that GPA tends to dominate MCATs in predicting performance in the clinical part of the curriculum.

In their multiple regression analysis using data from the classes of 1975 and 1976 at nine medical schools, Rolph, Williams, and Laniear (1978) found that MCAT scores of all parts (used in combination) were consistently better predictors of both Part I and Part II National Board of Medical Examiners test scores than

undergraduate GPA. Indeed, the Science MCAT alone was a better predictor than GPA in 11 out of 12 of their regressions. In his analysis of ABIM certifying exam scores, Bell (1977) found that GPA was a slightly better predictor than the Science MCAT, but the total predictive power of all MCATs was close to that of GPA.

One problem with overall GPA as a predictor of performance pertains to the differences in types of courses on which the GPA is based. The American Medical College Application Service (AMCAS) seeks to alleviate this problem in the material supplied to participating medical schools by reporting a combined GPA for biology, chemistry, physics, and math (commonly called "science GPA") and a GPA for all other courses ("non-science GPA"). AMCAS also reports GPA for each of these two categories for each year and includes information on credit hours for each category.

AMCAS also reports the total numbers of science and non-science hours that each applicant has completed. These data could be used in analyses to predict performance, but constructing a theoretical prediction model to incorporate them is not a straightforward matter. One might hypothesize a positive relationship between performance and, say, science hours in some part of the range on the assumption that better undergraduate grounding in science would contribute to better performance. However, it is also reasonable to hypothesize a negative relationship between science hours and performance beyond some amount of science course work because that might reflect a narrow knowledge base.

Use of GPA as a performance predictor is hampered by the problem of restriction of range, as is use of the MCAT. A recent study of medical school applicants by Gordon (1977) shows that undergraduate GPAs of admitted applicants have continued to rise. This has been a trend for at least the last decade, which means that problems due to restriction of GPA range have become progressively worse.

Another factor used to predict performance is the quality of the undergraduate school attended by the medical student (or applicant). This may be viewed as a way of correcting GPA for the difficulty of the undergraduate curriculum. In theory, it should be possible to

adjust GPA in this manner to improve predictive power, and Clapp and Reid (1976) obtained such a result in their analysis of NBME Part I scores and other performance measures at the University of Missouri, Columbia School of Medicine.

Other such studies have chosen to use an index of undergraduate school quality as a separate variable to explain performance in a multivariate framework. Bell (1977) found a statistically significant relationship between selectivity of the undergraduate school (a scaling of selectivity from the *Barron's Profile of American Colleges and Universities*) and scores on the ABIM certifying exam.[7] Rolph, Williams, and Laniear (1978) found a rescaled Barron's index to be significantly ($p < .05$) related to majority student scores on the mean of Part I and Part II of the NBME exam, although the relationship did not hold for all exam subparts. The same study found no statistically significant relationship between the selectivity index and minority student performance on the NBME exams. By contrast, Evans et al. (1975) found the "Astin score," a seven point scale of undergraduate college selectivity (Astin, 1971), to be the best predictor of several criteria of minority student performance during the first two years of Case Western Reserve University medical school.

A number of demographic variables (e.g., age, sex, marital status) have been used in various analyses of performance. The results have been mixed, perhaps because of the differences in the treatment of both the explanatory and performance variables. For example, Johnson and Hutchins (1966) found that married students were less likely to drop out of medical school but found no relationship between age and attrition. By contrast, Bell's (1977) multiple regression analysis showed a strong negative statistical relationship ($p < .001$) between age at graduation from medical school and ABIM exam performance. Earlier, Woodward (1968) had found a strong negative relationship between age and performance on Part II of the NBME exams.

The patterns of male and female performance differ significantly according to the type of measure used. For example, Rolph, Williams, and Laniear (1978) found no statistically significant differences between

male and female means on Part II of the NBME exam, but women score significantly higher (21 points, $p < .01$) on the psychiatry subtest. The results are almost exactly opposite, with men scoring higher, on the surgery subtest.

Johnson and Sedlacek (1975) show attrition rates that are significantly higher for female students from entering classes of 1968-1970. However, the differences seem to disappear in later years, which suggests that nonacademic factors may have accounted for the earlier higher attrition of women.

Considerable research has been done on noncognitive predictors of performance. These studies, even more than those of cognitive variables, tended to avoid multivariate analysis. In part this may be explained by the difficulty in developing an acceptable theory for the use of noncognitive variables in combination with other factors related to various measures of performance.

The most widely used noncognitive predictor of performance is the personal interview. Nevertheless, the interview eludes analysis regarding validity for several reasons. First, interviewers appear to be looking for many qualities that are not easily labeled, much less quantified--personal commitment to medicine, interpersonal skills, emotional stability, etc. When it is possible to label and quantify such factors, it is difficult to construct a theory of how they should relate to quantifiable performance measures.

Second, analysis of interview data has been plagued with problems of interrater reliability. Morse (1971) summarizes the results of some efforts to assess reliability. He concludes that agreement between interviewers using simple scales is usually in the 50 to 60 percent range.

Third, when conducting the interview, the interviewer generally has the applicant's other materials in hand. As a consequence, the interview tends not to be an independent assessment. For example, the interviewer's assessment of an applicant's motivation to become a doctor may be influenced by the applicant's undergraduate course load and GPA.

Notwithstanding the limited information on validity, the interview continues to be a widely used and trusted means of selecting applicants for admission (Char et al., 1975). Murden et al. (1978) offer evidence that the interview (by an interviewer with an applicant's other materials) improves an admissions committee's capacity to predict a medical student's performance during clinical clerkship. Committees search persistently for evidence of high or low motivation among their applicants, and anecdotal evidence seems strong that the interview provides a means for identifying at least some "outlier" applicants on this characteristic--the highly motivated applicant with a satisfactory but unimpressive undergraduate record, or the applicant with an outstanding premedical record and high MCATs whose true interest in clinical medicine is weak (Rhoads et al., 1974).

The efforts to predict performance at various points during medical education have had variable success, and the results do not provide a convincing case that one or more factors yield the best predictors. Neither do the results prove conclusively that any one of the factors admissions committees use is irrelevant for predicting performance. On the whole, the situation is not very satisfying for anyone who must inevitably choose whom to allow entry into the socially important and economically lucrative profession of medicine. However, the problems of the predictor variables--and they are many--are not nearly as troublesome as those of measuring "physician performance."

There is near universal agreement that the quality of care a physician provides is "what really counts."[8] But quality of care has been elusive of measurement. Brook (1973) has shown that quality ratings may differ significantly, depending on the metric used. However, one may be optimistic that the growing concern with quality assurance within the medical profession and the federal government will lead to better physician performance measures. This alone will not make it possible to evaluate the predictive validity of various factors used to select medical students. Although the quality of care the practicing physician provides may be assessed by the local Professional Standards Review Organization (PSRO), the physician's

right to privacy precludes that organization or any other from obtaining data on his or her premedical school characteristics or medical school performance.

The problems of both protecting privacy and avoiding self-selection bias in studies of physician performance are not new, but the environment for such research seems to have been better in the past than at present. The pioneering study by Peterson et al. (1956) examined the relationship between both general and specific assessments of quality of care delivered by general practitioners and their medical school ranks. They found positive, statistically significant relationships for younger (age 28-35) physicians but none for older physicians.[9] Price et al. (1971) collected data on some 800 Utah physicians and found no relationship between performance in medical school and performance in practice. However, their analysis involved only limited direct assessment of medical practice.[10] In their review of these studies and the other limited literature on the subject, Wingard and Williamson (1973) conclude that "little or no correlation exists between academic and professional performance."

On balance, we agree with their conclusion regarding evidence in the literature. However, we find study limitations as plausible an explanation of the failure to discover correlations as the argument that no relationship exists between academic and professional performance.

Moreover, we believe there is at least limited indirect evidence that such a relationship does exist. For example, Bell (1977) found that MCATs, medical school grades, and National Board scores were statistically significant predictors of performance on the internal medicine certifying exam. In a contemporary study, Brook and Williams (1976) found that board certified physicians performed significantly better than noncertified physicians on the quality of care criteria used by the New Mexico Foundation for Medical Care. Although indirect evidence of this sort is not sufficient to validate the performance measures used, it does not support the view that evaluation in medical education is irrelevant to improving health care.

AFFIRMATIVE ACTION

The objectives of affirmative action programs that pertain to medical school admissions are to reduce or eliminate the underrepresentation of women and certain minority groups. Although papers on affirmative action programs in the late 1960s and early 1970s often presented data on both women and minorities (Hutchins, Reitman, and Klaub, 1967; Johnson and Sedlacek, 1975), the problems of increasing representation in medical school classes were never too similar for white women and racial minorities. Consequently, the programs and policies for the two groups have differed sharply. For women, the problem was simply to eliminate actual sex discrimination in the admissions process. For minorities, the problems were more difficult: to increase the eligible applicant pool; to find means of selecting from the pool those who could complete the M.D. curriculum; and, finally, to develop special tutorial programs to help admitted applicants to cope with the difficult curriculum. We describe the literature on minority affirmative action first and in a more comprehensive manner, then studies of equal opportunity for women.

Affirmative Action for Minorities

There is little information about the opportunities for minority access to medical education before the mid-1960s. Blacks were the only minority group that had been singled out for study. In 1958, Reitzes published *Negroes and Medicine*, which documented the fact that about three-fourths of all black medical students were in two schools, Howard and Meharry. Black enrollment in medical schools stayed roughly constant between the mid-1950s and mid-1960s, but black enrollment in predominantly white medical schools actually declined during that period (Hutchins, Reitman, and Klaub, 1967). Reitzes (1958) documented that it would be necessary to relax admissions standards for MCATs and GPAs to increase black medical student enrollment significantly. This began to occur in the late 1960s.[11]

The growth in black and other minority medical student enrollment has been described in some detail by Jarecky (1969), Curtis (1971), Johnson, Smith, and Tarnoff (1975), and Odegaard (1977). The

1954 Supreme Court decision in *Brown v. Board of Education* removed legal barriers to admission of blacks to medical schools. The National Medical Fellowships, Inc. had functioned in the 1950s to help reduce financial barriers. However, the white majority was slow to act. In 1966 Edwin Hutchins gave his report on minority underrepresentation to the AAMC annual meeting. Earlier, minority fellowship funds had been provided by the Alfred P. Sloan Foundation and the Josiah Macy, Jr. Foundation, among other organizations. Social concern for the plight of minority groups was mounting steadily after the mid-1960s, but Odegaard (1977) identifies the assassination of Dr. Martin Luther King, Jr. as an important catalyst for affirmative action. In any case, the pace of institutional activity quickened, and minority enrollments rose after 1968.

The AAMC received grants from the U.S. Office of Economic Opportunity for an Office of Minority Affairs in 1969 and appointed a Minority Task Force. In 1970, the AAMC Executive Council made a strong policy statement favoring affirmative action and setting ambitious goals for minority admissions (Odegaard, 1977). In 1969, the AAMC published *Minority Student Opportunities in U.S. Medical Schools, 1969-1970*, which is now in its fifth edition. While continuing to publish data on minority recruitment and retention in medical schools, the AAMC began to sponsor workshops aimed at helping schools to deal more effectively with minorities during the admissions process.

The problem for every medical school admissions committee was to develop criteria for selecting minority students whose premedical school credentials would generally not have made them competitive with white students if they were judged by the same standards. Valid minority admission criteria were needed both because the schools wanted to ensure that they had not "wasted" first-year class places on minorities who could not or would not graduate, and because they needed to justify their selection of minority students over seemingly better qualified white students by the success of the former. There are numerous reports in the literature describing individual schools' experience during the early years of affirmative action (Lea and Farias, 1972; Ramsay, 1973; Plagge et al., 1974; Pearse and Gorelik,

1975; Perry, Philips, and Mahan, 1976; Geertsman, 1977; Beck et al., 1978). Documenting the rapid growth of affirmative action efforts, Wellington and Montero (1978) summarize the types of special minority programs offered by all schools in 1968 and 1972.

Finding sufficient numbers of qualified minority applicants has been a problem for medical schools since affirmative action programs began, but this problem became more acute as demand among medical schools for qualified minorities grew faster than the supply. Facing this problem and experiencing difficulty with the poorly prepared minorities already admitted, medical schools and undergraduate institutions began to develop programs for early identification of prospective minority medical school applicants. In general, these programs are aimed at minority students who are judged to be promising candidates for health careers during their last years of high school or early years of undergraduate school. Usually such students are then selected to participate in special summer indoctrination and science enrichment programs and to receive curriculum counseling and tutorial assistance during the regular school year. Programs of this general type have been described by Jackson (1972), Marshall (1973), Feldman and Burnett (1973), Ballard, James, and Wolff (1974), and Clemendor and Moore (1978).

Central to the concept of affirmative action was a relaxation of admissions standards for minority applicants. Smith (1973) found that the weighting of student characteristics by admissions committees was quite different for minority and majority applicants. Carter et al. (1974) analyzed admissions processes in ten medical schools using multivariate statistical methods and reported the estimated effect of minority status on admissions probability, controlling for preadmissions characteristics.[12] Rolph, Williams, and Laniear (1978) analyzed data on all applicants to all medical schools in 1972 through 1975 and developed separate equations for minority and majority applicants to predict an individual's acceptance by at least one medical school. The results showed significant differences between the equations for majority and minority applicants.

Waldman (1977) compared GPAs and MCATs of 1976-77 applicants from low income families (combined income below $10,000) with those of other applicants for both majority and minority groups. His results show that minority group scores were consistently lower than majority group scores, but that within-group differences in GPAs and MCATs seem little affected by family income. Waldman considered hypothetical situations in which either science MCAT or GPA were used as the sole admissions criteria and found that in such circumstances minority admissions would fall from about 9 percent to between 2 and 3 percent of the entering class.

As experience with affirmative action programs increased, it became possible to conduct more formal analyses of the performance in medical school of the minority students for whom traditional admissions criteria had been relaxed. Johnson, Smith, and Tarnoff (1975) showed that the proportion of students dismissed or leaving medical school before graduation is higher for minorities than majorities. Similarly, minorities are less frequently promoted with their class. Notwithstanding these differences, the combined attrition and repeating rates for minorities were low (less than 20 percent) in absolute terms. Smith (1973) examined factors that appear to be related to attrition among the two groups.

Criteria for decisions about whom to retain, dismiss, and promote must inevitably vary across medical schools. This makes such measures of success or failure difficult to interpret although of great significance to the student in the aggregate. Several studies have analyzed minority performance using both standardized and unstandardized measures of performance. Simon and Covell (1975) compared the performance of one group of 21 medical students at the University of California, San Diego, who were admitted by the "regular" route with 23 admitted by a "variance" (affirmative action) route. Although their results showed that the minority group scored significantly lower on both the NBME Part I exam and clinical clerkship ratings, the *average* for that group was well above passing level on all measures. Seven of the variance (minority) group failed the

NBME exam, but only one of the group would have been admitted through the regular route.

Evans et al. (1975) used multiple regression analysis to assess which preadmissions characteristics predict minority performance on both locally constructed and NBME Part I examinations for students at the Case Western Reserve University School of Medicine. Their results indicate that the quality of the undergraduate school attended (as measured by the Astin selectivity index) was the best predictor of minority performance although GPA and MCAT also have modest predictive value.

Rolph, Williams, and Laniear (1978) analyzed data on minority and majority student performance on NBME parts I and II exam at ten medical schools. Their results show that the premedical school characteristics customarily available to admissions committees are valid predictors of performance on these exams. However, the weights for the factors (coefficients in a multiple regression) that predict performance differ for the two groups. In particular, measures of aptitude (verbal and quantitative MCATs) are relatively more important for minorities than for majorities. Undergraduate GPA and science MCAT dominate as predictor variables for white students.

Overall assessments of academic medicine's minority affirmative action programs differ sharply depending upon the commentator. The sheer numbers tell a story of rapidly improving access of minorities to medical education opportunities. Enrollment increased more than fivefold in the ten years following 1968, but it fell short of the 12 percent of total enrollment goal set by the AAMC Task Force in 1970. It soon became clear that not everyone shared the Task Force's goal or, more correctly, that some were unwilling to accept the consequences of efforts to achieve it.

In terms of academic credentials, the white medical school applicant pool was improving in quality, but it was becoming increasingly difficult for white students to gain admission because increasing numbers of first-year places were given to minority applicants. This "reverse discrimination" led to legal action by white applicants who had failed to gain admission. Medical school faculty became concerned

about the effect of affirmative action on academic standards (Davis, 1976). Those involved in the medical school admissions process faced the dilemma: How to compensate in the admissions process for the deprivation of racial and ethnic minority applicants and yet to be fair to highly qualified white applicants (Ramsey, 1977). Numerous articles and editorials show that those who supported affirmative action clearly felt that the programs were threatened (Abarbanel, 1976; Burke, 1977; Prieto, 1978).

The case of Allan Bakke, a white applicant who had been refused admission to the medical school of the University of California at Davis, became the focal point for debate over the legality and philosophy of affirmative action programs (University of California Regents v. Bakke, No. 76-811). Sindler (1978) analyzes the history and disposition of this case, which took the U.S. Supreme Court a year and a half to decide and elicited 57 *amicus* briefs.[13] Although the Court's opinion in the Bakke case, announced on June 28, 1978, is complex in presentation and interpretation, the two basic components of the decision are conceptually straightforward: First, the Court ruled that U.C. Davis' system of quotas for minority admissions violated Title IV of the 1964 Civil Rights Act. It therefore ordered Bakke admitted to medical school. Second, the Court (in reversing the lower court's decision) held that race or ethnic origin could be considered, among other factors, in school admission decisions.

The Bakke decision evoked varied responses (Bork, 1978; Jackson, 1978; Marshall, 1978; Novak, 1978; Sowell, 1978). Perhaps most significantly, Cooper wrote an editorial in the *Journal of Medical Education* (1978) clearly indicating the academic medical community felt the Bakke decision left ample scope for meaningful affirmative action programs. Only the mechanism of quotas had been ruled as illegal. Medical schools still faced the difficult problem of finding admission criteria that would enable them to achieve a balance among (1) increasing minority representation in the medical profession, (2) ensuring graduates were technically well prepared for medicine, and (3) giving white applicants with very good qualifications their deserved opportunity to pursue a medical career.

Equal Opportunity for Women

During the late 1960s and early 1970s, there was a growing concern within the medical education community and society more generally over the problem of providing equal opportunity for women to pursue medical careers. Although most of the early research on the medical school admissions process had used fairly unsophisticated analytic methods, there was some evidence to support claims of sex discrimination in medical school admissions throughout the 1950s and 1960s. There is considerably better evidence that most, if not all, medical school admissions committees had ceased to discriminate against women applicants by the mid-1970s.[14] Because sex discrimination in medical school admissions appears a thing of the past, we review the literature only briefly.

Early studies relied on three different kinds of data to examine sex discrimination: (1) the number of women relative to men in the medical profession; (2) the proportion of women applicants relative to men who were accepted for admission; and (3) the average MCAT scores and GPAs for accepted and rejected female and male applicants.

Although medicine has been a predominantly male profession throughout its history in the United States, that alone does not establish the fact of discrimination in medical school admissions. A major factor limiting the numbers of women in medicine has been the small number who apply to medical schools. The earliest data cited by Hutchins, Reitman, and Klaub (1967) show that the total number of women who *applied* to medical school was never as high as one fourth of the total number of the men who were accepted from 1930 through 1965. It is possible that women did not apply for admission because they believed that they would not be admitted, but the data on the proportions of both sexes accepted are not consistent with that belief. A more plausible explanation for the low numbers of women applicants and women doctors is the pervasive societal view about appropriate sex roles.

A higher proportion of women applicants were accepted in the 1930s than in the 1940s and 1950s. The picture is mixed for the 1960s. Each year since 1970, a higher proportion of women applicants

than men have been admitted (Gordon, 1977; Gordon and Johnson, 1978). Throughout this period, there has been a steady growth in the total number of women applicants--from 632 in 1939/1940 to 10,195 in 1977/78 --and in the proportion of women in the total applicant pool--from 5.4 percent to 25.1 percent.

In recent years the academic credentials of women applicants have on average been slightly better (less than one-tenth of a grade point) than for men (Dube and Johnson, 1976; Gordon and Johnson, 1978; Gordon, 1977). Data on MCAT performance show that women applicants tended to perform consistently slightly better on the verbal and general information subparts, and vice versa on the science and quantitative subparts.[15] The commonly used indexes of preparation for medical school --GPA and MCAT--show the qualifications for men and women applicants to be too similar for one to draw any strong inferences about sex discrimination in the admissions process.

Modern multivariate statistical techniques provide a far more sensitive test of the effect of sex and other factors on the probability of admission to medical school than simple cross tabulations of the sort that have most commonly been used in admissions analysis. Only in recent years have machine-readable admissions data and economical computer data processing made it feasible to perform such analysis. Using data from one medical school, Carter et al. (1974) found evidence of significant discrimination against women applicants in 1969, but such discrimination seemed to have disappeared by 1972. Using a similar method, Rolph, Williams, and Lee (1978) analyzed data on applicants to all medical schools for 1972, 1973, 1974, and 1975 to estimate the probability that an applicant would be admitted to at least one medical school. They found that majority women applicants enjoyed slight but statistically significant preferences in all four years. The only evidence of statistically significant sex preferences for minority applicants was in favor of women in 1974.

Early studies of medical school attrition (Johnson and Hutchins, 1966; Johnson and Sedlacek, 1975) showed that a higher proportion of women than men failed to complete medical school. However, even the earlier study showed little difference in male and female attrition

due to academic difficulties; that is, women left medical school most often for nonacademic reasons. Although the sex differences in dropout rates persisted through 1968-1973, the differences had all but disappeared by 1973. In any case, the dropout rates were so low--less than 4 percent of entrants fail to graduate--as to make any remaining sex differences of no practical consequence. Clearly, there is no reasonable basis for arguing that women applicants are less likely to complete medical training than their male counterparts.

As discussed above, very few multivariate analyses of performance in medical school could detect differences between male and female students, holding other factors constant. Analysis by Rolph, Williams, and Laniear (1978) showed minor, although statistically significant, differences in the performance of men and women on different subparts of the NBME exam. As with the MCAT, the differences are in favor of women on some parts and men on others. The maximum estimated difference in either direction was never greater than one-fourth of a standard deviation.

In summary, objective analysis shows that academic medicine has been responsive to societal concerns for increasing the opportunities for women in the medical profession. Women have applied to medical schools in steadily increasing numbers, have been admitted, and have performed on a par with men. Still less than a third as many women as men apply. As long as this situation persists, medicine will remain a predominantly male profession but not necessarily one that discriminates against its female members.

Notes to Sec. II

[1]We have already noted that a very small proportion of those who enter medical school fail to graduate as physicians. Thus admissions committees attain a high level of "success" in that the applicants they accept perform above minimum thresholds of academic performance.

[2]This section does not attempt to be comprehensive. It describes broad categories of studies that are relevant to the concerns of this report. Cuca, Sakakeeny, and Johnson (1976) have provided a comprehensive review in their monograph on the admissions process and

Barro (1973) reviewed the extensive literature on physician performance measures.

[3]A brief description of the MCAT and its four parts is contained in Section III of this report.

[4]For example, examination of appendix tables suggests that no more than about 15%, 3%, 22%, and 5% of accepted majority applicants at any of the ten medical schools in our study scored below 500 (the standardized mean) on the Verbal, Quantitative, General Information, and Science MCATs, respectively.

[5]This problem of restricted MCAT range could be further exacerbated because admitted applicants with low MCATs had other attributes (e.g., GPAs, strong recommendations) that led admissions committees to judge that their particular MCATs would underpredict performance.

[6]We draw this inference by substituting the standard deviations for the variables in their multiple regression equations and comparing the size of the MCAT "effect" with that of GPA. Even in their equation for "clinical competence," which uses only Science MCAT, its predictive power is greater than that of GPA for women students.

[7]See Section III below for a discussion of the Barron's index. In an exploratory analysis, Bell (1977) varied the order in which variables were entered in the regression on ABIM scores. He found that selectivity was a moderately better predictor than undergraduate GPA ($F = 7.0$ vs. 4.6), when year of graduation, age, and rank in class were controlled for.

[8]In recent years, public policymakers have also shown growing concern for measuring performance in terms of who receives the care and where the physician is willing to provide it--in a rural area or an urban ghetto.

[9]In this study, 94 of 102 randomly selected general practitioners in North Carolina were evaluated by internists who observed their actual practice. The measures included multiple ratings on the "process" of care in six different areas and an overall qualitative rating. Data on medical school performance were limited to estimated percentile rank in most of the cases. MCAT data were available for only a third of the physicians, and no relationship was found.

[10]Unlike Peterson et al., Price et al. relied on data from peer evaluation, interviews, and self-assessment together with indicators of achievement, such as board certification.

[11]Reitzes' data showed that in the 1950s the average MCATs of all black graduates were a little lower than the average MCATs of all *rejected* medical school applicants. However, the average MCATs of black graduates from predominantly white medical schools were 20 to 30 points above those of rejected applicants although they were still below the average of all accepted applicants.

[12]This analysis is the precursor of the research reported in subsequent sections of this report.

[13]This is believed to be the largest number of *amicus* briefs ever submitted, but Sindler was unable to find a comprehensive record of the numbers of such briefs over the history of the Court.

[14]It has been widely argued that male chauvinist attitudes are pervasive within medical schools and that these contribute to unpleasant experiences for women medical students. Our impression is that such attitudes are much less common now than in the past; but we have not attempted any documentation. The persistent problems women have faced during medical education are discussed in Speiler (1977) and Davidson (1978).

[15]Sex differences in MCAT scores averaged 21 points or about one-fifth of a standard deviation between 1972 and 1976.

III. METHODOLOGY

We are concerned with estimating the simultaneous effects of applicants' characteristics on their probability of being admitted to each of the ten medical schools in our study. As discussed in Sec. II, most previous formal analysis of the medical school admissions process has considered the statistical relationship of applicant characteristics, one at a time, to the admission decision. Our approach in this study and our earlier analysis (Carter et al., 1974) examines the effects of all quantifiable applicant characteristics simultaneously. That is, we estimate the relative weights that admissions committees gave to the various attributes (GPA, MCATs and so on) in deciding which applicants to admit from those who applied in a particular year.

We estimate these weights by using a multivariate statistical method called conditional maximum likelihood logistic regression, commonly shortened to *logit analysis*. This method permits us to develop an equation that estimates the probability of an applicant's being admitted to a particular medical school, using data on individual applicant characteristics and, for each case, whether the applicant was admitted or not.

The data on applicant characteristics are selected from those maintained by the American Medical College Application Service (AMCAS).[1] This is also the source of whether a particular medical school accepted the applicant for admission.[2]

We estimate separate equations for minority and majority applicants' admission probabilities by separating the applicant pool of each school into two subpopulations. We performed this separation because we determined from our discussion with medical school administrators and admissions committees that the evaluation processes for majority and minority applicants differ. This difference was confirmed by the results of our earlier analysis (Carter et al., 1974). For majority applicants we estimate separate admission equations for each year (1973 through 1975) for each of the ten schools. However,

the smaller size of the minority applicant pool makes it impossible to estimate separate equations accurately for each year. Hence we create a dummy variable for each year in the minority equation to account for any effect of year per se on the overall probability of admission of minority applicants.

The criteria used by the admissions committees vary from school to school. In general, all schools aim to select for admission only those applicants who can successfully complete the medical school curriculum. Beyond this concern with academic preparation, schools select applicants who seem well suited for the school's educational program objectives. For example, some schools emphasize the importance of producing medical scholars and researchers. Others emphasize the production of physicians dedicated to service in the primary care settings. Schools also take other specific individual attributes--such as sex, race, state of residence--into account in admissions decisions. As a rule, admissions committees also try to assess the suitability of applicants' personality and their dedication to a career in medicine.

Obviously, many applicant characteristics can be measured or at least categorized, but many others cannot.[3] In this study we deal with only quantifiable characteristics, which are used as variables in our equation to predict the probability of admission. Two kinds of variables are available for every applicant. One kind describes the academic background and preparation of the applicant, such as the undergraduate grade point averages, scores on the MCAT, quality of undergraduate school attended, and so on. The other kind describes other characteristics of the applicant, such as race, sex, state of residence, and so forth.

MODEL ESTIMATION PROCEDURES

We estimated each equation of a school's admissions probabilities using data on the characteristics of each applicant to the school and the outcome of the school's decision (accept or reject).[4] The logistic regression equation is of the form

$$p = \frac{1}{1 + e^{-(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}, \qquad (1)$$

where p is the probability of admission; α is a constant term; x_1, x_2, ..., x_k are the variables quantifying applicant characteristics, and β_1, β_2, ..., β_k are the coefficients (or weights) for each of the variables.[5]

The *maximum likelihood* method is used to estimate the coefficients α, β_1, ..., β_k in Eq. (1). The method gives estimates of the coefficients α, β_1, ..., β_k by finding values a, b_1, ..., b_k that maximize the probability of the observed outcomes for the individual applicants (1 if admitted, 0 if rejected).[6]

Logit analysis lends itself to convenient interpretation in the case of the admissions process. Each applicant to a particular school has an *estimated discriminant score*, D, that is determined by his or her characteristics and the estimated weights the school places on those characteristics.

$$D = a + b_1 x_1 + b_2 x_2 + \ldots + b_k x_k , \qquad (2)$$

which is seen as the natural logarithm of p/(1-p) in Eq. (1). An individual applicant's *probability of acceptance* at that particular school[7] is

$$p = \frac{1}{1 + e^{-D}} . \qquad (3)$$

The greater the value of D (the linear combination of characteristics that positively affects the applicants chances of admission), the more closely e^{-D} approaches zero, and p approaches one.

For some purposes, it is more convenient to use acceptance *odds* rather than probabilities. If p is the probability of acceptance, some algebra yields an equation for the *estimated odds on being accepted as*

$$\frac{p}{1-p} = e^{D} . \qquad (4)$$

That is, the discriminant score D is ln(p/1-p), the natural logarithm of the estimated acceptance odds. Combining Eqs. (2) and (4), we define *multiplicative factors* as:

$$A = e^{a}, \; B_1 = e^{b_1}, \; B_2 = e^{b_2}, \text{ etc.}$$

The equation for the *estimated odds* for a particular applicant to a particular school is

$$\frac{p}{1-p} = AB_1^{x_1} B_2^{x_2} \ldots B_k^{x_k} . \qquad (5)$$

That is, the odds of admission are a product of the multiplicative factors raised to the value of the corresponding (applicant characteristic) variable. This form of the admissions equation is particularly convenient for examining the effect of a change in a particular characteristic on an applicant's chances of acceptance. For example, using values for school 1 in Table 11, we calculate that a 100 point improvement in science MCAT would increase an applicant's odds of admission by a factor of about 10.5 ($= e^{.0235 \times 100}$). Being a home state resident increases odds by a factor of about 45 ($= e^{3.8093 \times 1}$). We estimate that an applicant whose estimated odds of acceptance were one to four (.2/(1-.2) or .25) would improve those odds by a factor of about 10.5 by improving his science MCAT by 100 points. The new odds would be 2.6 to 1. By simple algebra we see that the estimated probability of acceptance has thus increased from .20 to .72.

We obviously need measures of how well our statistical model of the admission process fits the actual data on applicant characteristics and admissions outcomes. As in the case of ordinary least squares regression, we need measures of the statistical significance of the coefficients ($b_1, \ldots, b_k$) on each of the individual predictor variables ($x_1, \ldots, x_k$) as well as a measure of the predictive value of the model as a whole. To measure the statistical significance of

the individual coefficient estimates $b_1, \ldots, b_k$ in logit regression, we use a t-statistic that is the estimated value of the coefficient b_i divided by its estimated standard deviation s_i. This approximates the familiar t-statistic used in multiple regression to test the hypothesis that a particular regression coefficient is different from zero.[8]

Unfortunately, there is no single measure of the overall goodness-of-fit for logistic regression that has the easily interpretable qualities of the coefficient of determination, R^2, which is commonly used for multiple regression with a continuous dependent variable. However, minus twice the maximized *log likelihood* ratio can be calculated from a maximum likelihood logit regression following an asymptotic chi-square distribution for testing the hypothesis that all the coefficients $b_1, \ldots, b_k$ are simultaneously equal to zero.[9] The function of this test statistic is similar to that of the F-statistic in multiple regression.

Using the log likelihood, we may calculate an "R^2" for logit regression that is analogous to the R^2 of linear regression in the same way that the log likelihood is analogous to the usual F-statistic. In this case R^2 can be interpreted as the decrease in unexplained variation in admissions outcomes that results from using the logistic regression model to predict each applicant's probability of admission as a function of his or her characteristics, rather than using the proportion of all applicants admitted (which is the naive prediction model assuming no relationship between applicant characteristics and admission probability).[10] Minus twice the maximum log likelihood ratio and the modified "R^2" are reported for each of the estimated admissions equations in the subsequent sections.

DATA

The data used in the analysis were provided by AMCAS with the permission of the ten schools that participated in the study. The variables used in our analysis are described briefly below.

Grade point average (GPA) is computed on a four point scale (A = 4, B = 3, C = 2, D = 1, F = 0), weighted by course hours, and

divided into *science* and *non-science* parts. Science GPA is the weighted average of all courses in biology, physics, chemistry, and math. Non-science GPA is the weighted average of all other courses. If AMCAS shows a missing value for GPA, as when an applicant attended an undergraduate school with a pass-fail system, a zero is recorded for GPA and the value of 1 (otherwise 0) is recorded for *missing science GPA* or *missing non-science GPA*. Thus the average GPA value a school's admissions committee assumes for applicants without GPA is obtained by dividing the coefficient for *missing science GPA* by the corresponding coefficient for *Science GPA*.[11]

Grade trend is the difference between the applicant's cumulative GPA for all (science and non-science) courses and his or her freshman GPA. A positive value for grade trend indicates improvement in grades over the period of undergraduate schooling to the point of application. A negative value indicates the opposite. The *missing grade trend* variable is treated like the missing GPA variable, and its coefficient can be interpreted as the average value assigned to applicants whose grade trend cannot be computed.

Science and *non-science* hours are the total number of credit hours completed in the course areas at the time of application.

The *Medical College Admission Test* (MCAT) is a four part standardized test that almost all medical schools require applicants to take during the 18 months before they wish to begin classes.[12] The *Verbal MCAT* measures knowledge of vocabulary and ability to perceive verbal relationships. The *Quantitative MCAT* is a test of ability to apply basic mathematical principles. The *Science MCAT* examines the applicant's knowledge of scientific material usually contained in introductory courses in biology, organic and inorganic chemistry, and physics. The *General Information MCAT* examines overall cultural knowledge and that of the social and behavioral sciences. Scores for each part are reported in the common standardized form with a range of 200 to 800, a mean of 500, and a standard deviation of 100.

To determine the effect of undergraduate school quality on an applicant's chances of admission, we construct a *selectivity index* for the applicant's undergraduate school using categories contained

in *Barron's Profiles of American Colleges.*[13] The undergraduate school codes used by AMCAS were matched to one of ten Barron's codes; missing or unmatchable schools were grouped with the Barron's "special" category. Rolph, Williams, and Lee (1978) used the resulting ten categories as dummy variables in discriminant analysis to predict which majority applicants to medical school were admitted to at least one school in each of the years 1973, 1974, and 1975.[14] The coefficients on each of the categories were rescaled 0 to 1, where the value of 0 is given to the Barron's category, the graduates of whose schools received lowest preference in a particular year, and the value of 1 was assigned to the category that received the highest preference. The discriminant analysis controlled for other student characteristics (e.g., MCAT, GPA, state of residence). Therefore, the rescaled selectivity index shown in Table 8 should be a close approximation of the average preference given by medical schools to applicants from broad categories of undergraduate colleges.[15]

Age is coded as the chronological age of the applicant at time of application minus 22 years, or zero if the applicant is 22 years old or less. This variable is used to determine whether being an older applicant affects the probability of admission when other factors are controlled for.

A number of other applicant characteristics were used in the analyses. These were coded as dummy variables that had the value of 1 if the applicant was in a particular category, otherwise 0. Variables treated in this way were:

- *Same undergraduate school.* The applicant attended undergraduate college at the university of which the medical school is a part.
- *Junior applicant.* The applicant applied to enter medical school at the end of his or her third year of undergraduate school.
- *Attended graduate school.* The applicant had attended or was currently enrolled in graduate school.
- *Female.* The applicant is a woman.

Table 8

SCALE FOR UNDERGRADUATE SCHOOL SELECTIVITY

Barron's Selectivity Rating Categories[a]	Estimated Selectivity Scale[b] 1973	1974	1975
Special or not available	.0856	.0329	.9711
Non-competitive	.0000	.0000	.0496
Less competitive	.1546	.0598	.0000
Competitive	.0855	.0230	.0035
Competitive +	.1098	.0885	.0857
Very competitive	.2302	.1662	.2519
Very competitive +	.3588	.2385	.3035
Highly competitive	.4360	.4291	.4284
Highly competitive +	.5960	.5333	.5175
Most competitive	1.0000	1.0000	1.0000

[a]Selectivity ratings from *Barron's Profiles of American Colleges*, Ninth Edition, Woodbury, New York, Barron's Educational Series, Inc., 1974.

[b]Selectivity scale for each year is based on estimated coefficients in discriminant analysis of each year's majority admissions for all applicants to all U.S. medical schools. The *Barron's* categories were used as dummy variables in a discriminant analysis that contained other preadmission characteristics of applicants. The resulting coefficients have been rescaled for 0 to 1 for purposes of the analysis in this report. See J. E. Rolph, A. P. Williams, and C. L. Lee, *The Effect of State of Residence on Medical School Admissions*, R-2014-HEW, The Rand Corporation, January 1978.

- *Home state resident.* The applicant is a legal resident of the state in which the medical school is located.
- *Asian American.* The applicant has identified himself or herself as a U.S. citizen of oriental race (used only in majority admissions analysis).
- *Black.* The applicant has identified himself or herself as a Black or Afro-American (used only in the minority admissions analysis).
- *1973, 1974, 1975.* The applicant applied to enter medical school in the indicated year (used only in minority analysis).[16]
- *Interstate agreement.* The applicant was a legal resident of a state whose residents the medical school has agreed to give preferential treatment in admissions.

Notes to Sec. III

[1]The American Medical College Application Service is a central clearing house for information on medical school applicants. Applicants complete questionnaires and provide transcripts and other data to AMCAS, which assembles it into a standard format for distribution to participating medical schools. The medical schools use the AMCAS data together with supplementary application forms and subjective assessments of interviews and letters of recommendation to decide whether or not to accept each applicant. AMCAS is periodically informed of the school's interim or final decision on each applicant (accept, reject, pending).

Although not all medical schools participate fully in AMCAS, almost all applicants provide application data to AMCAS because they apply to at least one AMCAS school. If a student has applied to one AMCAS school, AMCAS keeps track of the student's status with all schools to which he or she applied. The final AMCAS status report for each year (1973-1975) is the source of our information on outcomes of the admissions process.

[2]Because each applicant applies to an average of nine different schools, he may be accepted by more than one school. Because our analysis emphasizes the decisionmaking processes of the schools, we are concerned with predicting acceptances by the school, whether the applicant attends that or another school.

[3]A terse description of each medical school's admissions criteria is presented in *Medical School Admissions' Requirements, USA and Canada* (year), an annual publication of the Association of American Medical Colleges, Washington, D.C.

[4]The applicants with incomplete records on MCATs and those for which the schools reported no action were eliminated from the analysis of every school.

[5]The form of the equation, in terms of variables used, is the same for all ten schools with two exceptions. An additional dummy variable is used for two schools to denote whether an applicant is a resident of a neighboring state from which the school receives financial support in return for giving preference to applicants from those states. All variables in the equation are in their original form (i.e., there are no transformations of variables, such as logarithms or powers). There are also no interactions between variables. The effects of alternative forms of the variables were examined during early exploratory analysis, but in no case did they add significantly to the predictive power of the model.

[6]We estimated the coefficients using the maximum likelihood estimation program in the STATLIB package (see STATLIB manual by W. M. Brelsford and D. A. Relles, The Rand Corporation, forthcoming). A good description of logit regression and estimation methods is contained in Cox (1970). Several articles offer comparisons between maximum likelihood estimation used here and discriminant analysis estimation used for the admission probability models in Rolph, Williams, and Lee (1978). See Press and Wilson (1978, p. 705); Efron (1975, pp. 892-898); and Halperin, Blackwelder and Verter (1971, pp. 125-158).

[7]We perform such calculations for hypothetical applicants in Sec. IV.

[8]For a more complete description of the calculation and interpretation of the t-statistics in logit regression, see Morris and Rolph (1978, pp. 196-200); and Brelsford and Relles, forthcoming.

[9]See Morris and Rolph (1978, pp. 199-200) for discussion of this analogue.

[10]For a technical discussion of the attributes of various descriptive statistics of goodness of fit, see Efron (1978, pp. 113-121).

[11]AMCAS files contain values for each year of undergraduate and graduate training. Our analysis uses a cumulative value--that is, the average GPA for all courses completed up to the point of application.

[12]A new MCAT was instituted in the spring of 1977. Littlemeyer (1977); also AAMC (1977).

[13]*Barron's Profiles of American Colleges*, Ninth Edition, Woodbury, New York, Barron's Educational Series, Inc., 1974.

[14]Laniear, Rolph, and Williams (1978).

[15]The scale of Table 8 follows the order of the Barron's index reasonably well at the top part of the scale, but less well at the bottom. This latter effect may be partially explained by the existence of some large public university systems that admit all applicants

with requisite high school credits but nonetheless have demanding science curricula. The large value for 1975 of the special or not available category is most probably because the school code was missing for a number of applicants from high quality undergraduate schools in that year. Of course, the medical school always knows the name of the undergraduate school even if it is missing from the AMCAS tape because it appears on an applicant's transcript.

[16]The years in the minority analyses are coded as categorical variables such that the coefficients measure the particular "year effect" as a difference from 1975.

IV. ANALYSIS OF MAJORITY AND MINORITY ADMISSIONS DECISIONS

Because we perform separate analyses of majority and minority admissions decisions in each of the ten schools, we present the results separately as well. We then compare the majority and minority admissions processes by examining hypothetical applicants' chances of admissions under each.

MAJORITY ADMISSIONS

Before estimating admissions equations for each medical school using maximum likelihood logistic regression, we compared mean values of accepted and rejected applicants on a number of characteristics. These means for each school in each year (1973, 1974, 1975) are shown in Appendix B, Tables B.1, B.2, and B.3. Not surprisingly, the mean values for accepted applicants are consistently higher than those of rejected applicants on all characteristics except the selectivity of the undergraduate school.[1] This inconsistency occurs only in four out of 30 cases.

Examination of the summary statistics on applicants to these ten schools shows the improvement that has occurred over the three periods in applicants' GPAs and MCATs. The 1975 means for all applicants at each of the ten schools are higher than the 1973 means for *science GPA*, *non-science GPA*, and all *MCAT*s except *General Information*.[2] This is consistent with the national data on all applicants' GPAs and MCATs. Most schools raised their standards for admission on these characteristics as their applicant pools improved. The exception is school 4, whose mean accepted applicant scores decline slightly between 1973 and 1975 on both GPAs and all four MCATs. This school's admissions committee appears to have been placing increased emphasis on other student characteristics that were negatively correlated with GPA and MCAT.

Tables 9, 10, and 11 show the logistic regression coefficients for each of the ten schools in our sample for each of the three years 1973, 1974, and 1975. The variables used in the regression were described in the previous section. Recall that dummy variables are used for

Table 9

ESTIMATED ADMISSIONS EQUATIONS FOR MAJORITY MEDICAL SCHOOL APPLICANTS AT TEN MEDICAL SCHOOLS, 1973
(Maximum likelihood regression coefficients, standard deviations in parentheses)

Predictor Variable	School									
	1	2	3	4	5	6	7	8	9	10
Science GPA	6.2942[c]	2.4678[c]	1.9594[c]	3.8166[c]	2.1078[c]	3.1162[c]	3.0985[c]	1.6296[c]	1.3086[c]	1.7888[c]
	(.4852)	(.4228)	(.3209)	(.2691)	(.3202)	(.3209)	(.3562)	(.2189)	(.3544)	(.6521)
Missing science GPA	14.0100	8.4454[c]	8.3898[c]	0.1728	9.6753[c]	11.9040[c]	14.3400[c]	6.4764[c]	11.9570	0.9599
	(16.0380)	(1.8867)	(2.0593)	(.1780)	(2.4715)	(3.3739)	(3.7666)	(1.4303)	(41.6480)	(10.6530)
Non-science GPA	1.2781[c]	0.4234	1.7325[c]	1.1672[c]	1.6535[c]	1.3242[c]	1.3600[c]	1.2537[c]	0.0575	1.3295[b]
	(.3773)	(.4026)	(.3479)	(.2558)	(.3456)	(.3485)	(.3416)	(.2320)	(.3695)	(.6250)
Missing non-science GPA	5.2069	5.1021[b]	5.3039[b]	-0.3718	4.0217	1.0725	1.4609	3.6486[c]	-6.3093	6.9075[a]
	(9.9658)	(1.9854)	(2.0947)	(17.7920)	(2.5084)	(3.5066)	(3.6732)	(1.4121)	(31.7390)	(4.1236)
Grade trend	1.6365[c]	0.6248	0.9561[c]	0.0678	0.2603	0.2556	0.5357	0.1246	0.4445	0.4800
	(.3662)	(.4269)	(.3567)	(.2679)	(.4060)	(.3485)	(.3575)	(.2721)	(.3796)	(.6714)
Missing grade trend	-1.6184[a]	0.3068	0.6804[a]	0.7021	-0.0204	-0.1149	-0.2502	0.1058	-0.9464	0.0378
	(.9739)	(.8790)	(.3953)	(.4292)	(.3909)	(.7570)	(.5396)	(.2737)	(1.0772)	(1.6391)
Science hours	-0.0050	0.0000	0.0044	0.0066	0.0067	-0.0170[b]	-0.0055	-0.0045	-0.0084	0.0067
	(.0066)	(.0075)	(.0051)	(.0046)	(.0062)	(.0067)	(.0058)	(.0044)	(.0080)	(.0103)
Non-science hours	-0.0085	0.0090	0.0023	-0.0007	0.0027	-0.0103[a]	-0.0115[b]	-0.0054	0.0025	0.0146
	(.0067)	(.0059)	(.0043)	(.0041)	(.0053)	(.0053)	(.0050)	(.0037)	(.0065)	(.0102)
Verbal MCAT	0.0100[c]	0.0039[a]	0.0003	0.0060[c]	0.0007	0.0020	0.0059[c]	0.0028[b]	0.0019	-0.0015
	(.0019)	(.0022)	(.0015)	(.0012)	(.0016)	(.0016)	(.0016)	(.0012)	(.0020)	(.0037)
Quantitative MCAT	0.0195[c]	0.0024	-0.0016	0.0046[c]	0.0040[b]	0.0015	0.0050[c]	0.0048[c]	-0.0020	0.0057[a]
	(.0020)	(.0018)	(.0014)	(.0011)	(.0016)	(.0015)	(.0016)	(.0011)	(.0018)	(.0034)
General information MCAT	0.0048[b]	0.0036	0.0013	0.0011	0.0041[c]	0.0026	0.0021	0.0019[a]	-0.0013	0.0035
	(.0019)	(.0023)	(.0014)	(.0012)	(.0015)	(.0017)	(.0015)	(.0011)	(.0021)	(.0040)
Science MCAT	0.0189[c]	0.0045[b]	0.0055[c]	0.0092[c]	0.0077[c]	0.0086[c]	0.0108[c]	0.0055[c]	0.0035	0.0168[c]
	(.0023)	(.0021)	(.0016)	(.0013)	(.0017)	(.0018)	(.0018)	(.0012)	(.0022)	(.0043)
Same undergraduate school	1.6509[c]	1.5416[c]	1.0565[c]	4.4501[c]	2.9560[c]	0.5284[b]	1.0163[c]	1.7985[c]	0.4803	-0.7527
	(.6264)	(.3410)	(.2689)	(.4963)	(.3477)	(.2435)	(.3157)	(.3384)	(.4647)	(.6090)
Selectivity index	1.9822[c]	1.4368[c]	1.5750[c]	0.6771[a]	1.4284[c]	0.1011	1.7605[c]	1.0274[c]	1.5681[c]	1.4088[a]
	(.5341)	(.5527)	(.3432)	(.3701)	(.2971)	(.5075)	(.4096)	(.2048)	(.3977)	(.8295)
Junior applicant	-0.5182	-0.5256	-0.8635[a]	-0.7416[b]	0.4151	-0.3881	-1.0352[b]	-0.3592	-7.4744	-2.6625[b]
	(.5051)	(.6089)	(.4663)	(.2965)	(.3447)	(.4473)	(.4270)	(.3300)	(13.0120)	(1.0496)
Attended graduate school	-0.1042	-0.9743	-0.6362	-1.1142[b]	-0.6718	0.4017	-0.3028	-0.2012	0.2783	1.0340
	(.5351)	(.6308)	(.4157)	(.4374)	(.5560)	(.4468)	(.4991)	(.3516)	(.4902)	(.8045)
Age	-0.3340[c]	-0.1109	0.0847	-0.2626[c]	-0.1259	-0.0340	0.0067	0.1061[b]	-0.1106	-0.1694
	(.1184)	(.1028)	(.0613)	(.0892)	(.1122)	(.1005)	(.0661)	(.0515)	(.1169)	(.1228)
Female	0.1628	-0.2079	0.3060	0.3929[a]	0.9528[c]	-0.1577	0.2847	0.5664[c]	-0.3914	0.9498
	(.3451)	(.3847)	(.2034)	(.2096)	(.2044)	(.2795)	(.2346)	(.1482)	(.3368)	(.6080)
Home state resident	4.7619[c]	1.5353[c]	0.6958[c]	0.9895[c]	2.9193[c]	4.2272[c]	1.5091[c]	0.6215[c]	3.5530[c]	5.4277[c]
	(.3168)	(.3192)	(.1947)	(.3419)	(.2767)	(.6031)	(.2210)	(.1770)	(.4044)	(.6854)
Constant	-61.4680	-22.2740	-20.6140	-32.7130	-27.9550	-27.1510	-33.6470	-21.7280	-9.5375	-31.6650
Log likelihood ratio	591.5413	160.1082	122.3420	512.9881	243.8873	367.1841	321.7037	268.5042	89.8905	127.6969
R^2	0.6680	0.4015	0.1839	0.3961	0.3208	0.4854	0.4065	0.2273	0.2463	0.6022

[a]Significant at .10 level.

[b]Significant at .05 level.

[c]Significant at .01 level.

Table 10

ESTIMATED ADMISSIONS EQUATIONS FOR MAJORITY MEDICAL SCHOOL APPLICANTS AT TEN MEDICAL SCHOOLS, 1974
(Maximum likelihood regression coefficients, standard deviation in parentheses)

Predictor Variable	School 1	2	3	4	5	6	7	8	9	10
Science GPA	5.4646[c]	3.4921[c]	2.6396[c]	3.0165[c]	2.8969[c]	2.9726[c]	4.2681[c]	2.3612[c]	1.4526[c]	1.3112[b]
	(.4599)	(.5677)	(.3354)	(.2664)	(.3620)	(.3439)	(.4535)	(.2525)	(.3727)	(.5935)
Missing science GPA	15.8130	14.6180[c]	8.3732[c]	5.6134	10.6930[c]	4.3880	15.7770[c]	8.9940[c]	7.1759[c]	8.0219
	(14.2150)	(2.3929)	(1.7657)	(17.0050)	(1.9027)	(12.9050)	(2.0393)	(1.3889)	(2.3093)	(67.9000)
Non-science GPA	1.0079[b]	1.5139[c]	0.9548[c]	0.9136[c]	1.3046[c]	1.3484[c]	2.2947[c]	1.5725[c]	0.0170	1.0175[a]
	(.3972)	(.5662)	(.3074)	(.2601)	(.3502)	(.3292)	(.3910)	(.2580)	(.3653)	(.5724)
Missing non-science GIA	0.1842	6.4489[b]	4.8364[c]	-1.9556	4.7005[b]	3.1068	8.2533[c]	5.8972[c]	-0.1731	2.7113
	(13.3820)	(2.5711)	(1.4475)	(15.5440)	(1.8349)	(2.0688)	(1.9539)	(1.3246)	(1.8074)	(60.4680)
Grade trend	1.0626[c]	1.2343[b]	0.6597[b]	0.5953[b]	0.9021[b]	0.0534	0.2983	0.5548[b]	0.3079	0.5248
	(.3912)	(.5517)	(.3237)	(.2495)	(.4147)	(.3276)	(.4240)	(.2711)	(.3827)	(.5440)
Missing grade trend	0.2164	0.7712	-0.3927	-0.1243	-0.4021	1.1934	-0.5408	-0.2540	0.3725	-5.8153
	(.8759)	(.7784)	(.4495)	(.6059)	(.4379)	(.8177)	(.5407)	(.3403)	(.6219)	(22.0130)
Science hours	-0.0100	0.0097	-0.0006	0.0044	-0.0038	-0.0144[b]	-0.0103[a]	0.0104[c]	-0.0037	0.0044
	(.0065)	(.0082)	(.0044)	(.0043)	(.0068)	(.0065)	(.0061)	(.0047)	(.0079)	(.0097)
Non-science hours	-0.0096	0.0079	0.0017	-0.0001	-0.0071	-0.0137[b]	0.0003	0.0059	-0.0037	0.0101
	(.0060)	(.0064)	(.0037)	(.0039)	(.0055)	(.0059)	(.0047)	(.0037)	(.0065)	(.0066)
Verbal MCAT	0.0071[c]	0.0026	0.0031[a]	0.0067[c]	0.0080[c]	0.0019	0.0056[c]	0.0049[c]	-0.0001	0.0023
	(.0018)	(.0025)	(.0017)	(.0013)	(.0018)	(.0015)	(.0019)	(.0014)	(.0021)	(.0034)
Quantitative MCAT	0.0178[c]	-0.0015	0.0009	0.0093[c]	0.0034[a]	-0.0007	0.0101[c]	0.0055[c]	0.0059[c]	0.0092[c]
	(.0023)	(.0026)	(.0016)	(.0014)	(.0019)	(.0015)	(.0023)	(.0014)	(.0021)	(.0032)
General information MCAT	0.0041[b]	0.0033	0.0014	0.0038[c]	0.0005	0.0022	0.0020	0.0057[c]	0.0040[a]	0.0005
	(.0017)	(.0027)	(.0015)	(.0012)	(.0016)	(.0016)	(.0017)	(.0013)	(.0023)	(.0035)
Science MCAT	0.0235[c]	0.0106[c]	0.0064[c]	0.0069[c]	0.0078[c]	0.0156[c]	0.0179[c]	0.0079[c]	0.0025	0.0050
	(.0026)	(.0028)	(.0017)	(.0014)	(.0018)	(.0019)	(.0023)	(.0014)	(.0021)	(.0033)
Same undergraduate school	1.7455[c]	2.0004[c]	1.2702[c]	6.0432[c]	2.5000[c]	0.6607[c]	0.9642[c]	2.4214[c]	1.3622[c]	0.5255
	(.4982)	(.3842)	(.2467)	(.4621)	(.3077)	(.2545)	(.2871)	(.3370)	(.4413)	(.4484)
Selectivity index	1.4199[c]	3.1201[c]	1.9626[c]	0.5176	1.6538[c]	1.2517[c]	1.6960[c]	1.7569[c]	1.1902[c]	-0.2955
	(.5132)	(.6209)	(.3167)	(.3521)	(.2878)	(.4427)	(.4206)	(.2155)	(.3773)	(.9681)
Junior applicant	-1.8493[c]	-0.4592	-0.1212	-0.4792	0.1485	-2.3493[c]	-1.3527[c]	-0.5541	-1.8891[a]	-2.7017[b]
	(.7082)	(.9334)	(.4367)	(.3925)	(.3991)	(.4633)	(.5048)	(.4234)	(1.0900)	(1.2288)
Attended graduate school	0.3315	1.1591[a]	0.4096	-0.1330	-1.4854[b]	0.1823	0.1540	-0.1153	0.5022	-0.9899
	(.5223)	(.6849)	(.3023)	(.3487)	(.6724)	(.4792)	(.4317)	(.3542)	(.4897)	(.6542)
Age	-0.2299[b]	-0.1272	0.0616	-0.1227[a]	0.0415	-0.0881	-0.0851	-0.2018[c]	-0.1782[a]	-0.0232
	(.0923)	(.1003)	(.0479)	(.0675)	(.1128)	(.1078)	(.0735)	(.0756)	(.1063)	(.0743)
Female	0.1203	0.1576	0.5398[c]	0.0135	0.9765[c]	0.4749[a]	0.0722	0.4941[c]	0.5571[b]	1.1120[c]
	(.2976)	(.3742)	(.1835)	(.2022)	(.2003)	(.2478)	(.2419)	(.1572)	(.2732)	(.4268)
Home state resident	3.8093[c]	2.2681[c]	1.1542[c]	1.1251[c]	3.0635[c]	5.8307[c]	1.6465[c]	0.7935[c]	3.9296[c]	3.5809[c]
	(.3121)	(.4079)	(.2000)	(.2928)	(.2878)	(.7299)	(.2635)	(.1851)	(.4295)	(.5126)
Asian American	-0.3041	-7.1497	0.4493[a]	-0.4681	0.2610	0.8532	-0.4142	0.0500	0.1729	-4.7803
	(.6979)	(12.3880)	(.2659)	(.4386)	(.5292)	(.8257)	(.3237)	(.3479)	(.8153)	(14.0780)
Constant	-58.1300	-32.4960	-24.8920	-32.9360	-30.8910	-31.7200	-49.9770	-32.4340	-17.0480	-23.4330
Log likelihood ratio	531.2029	181.4584	190.2275	466.7607	264.8744	462.2787	412.6738	366.3879	123.8414	96.3358
R^2	0.6087	0.5075	0.2436	0.3781	0.3465	0.5319	0.5011	0.3210	0.3037	0.4462

[a]Significant at .10 level.

[b]Significant at .05 level.

[c]Significant at .01 level.

Table 11

ESTIMATED ADMISSIONS EQUATIONS FOR MAJORITY MEDICAL SCHOOL APPLICANTS AT TEN MEDICAL SCHOOLS, 1975
(Maximum likelihood regression coefficients, standard deviations in parentheses)

Predictor Variable	School									
	1	2	3	4	5	6	7	8	9	10
Science GPA	6.0588[c]	3.4552[c]	2.6356[c]	3.0108[c]	3.6251[c]	3.0535[c]	3.5942[c]	1.1888[c]	2.2597[c]	2.8275[c]
	(.5618)	(.5302)	(.3812)	(.3538)	(.4498)	(.3566)	(.4210)	(.2397)	(.4682)	(.6817)
Missing science GPA	16.3500	16.2940[c]	9.6122[c]	7.3766	19.0460[c]	10.2660	14.8050[c]	4.7340[c]	9.6514[c]	8.6343
	(25.7530)	(2.5608)	(1.9122)	(27.2730)	(3.5006)	(37.0960)	(1.8789)	(1.5471)	(2.7082)	(71.9190)
Non-science GPA	2.0540[c]	0.3602	0.6054[a]	0.3745	0.8746[b]	1.6120[c]	1.2151[c]	0.3485	0.7723[a]	0.5185
	(.4411)	(.4625)	(.3407)	(.3582)	(.4285)	(.3814)	(.3701)	(.2574)	(.4585)	(.7300)
Missing non-science GPA	7.7560[c]	2.1419	1.1172	-7.1196	-0.7356	-0.0841	3.8343[b]	1.3609	3.3431	(13.3550
	(2.5036)	(2.1133)	(1.8006)	(25.1020)	(3.3905)	(26.2090)	(1.9130)	(1.3064)	(2.5366)	(62.2320)
Grade trend	1.2232[c]	0.8039	0.4230	0.2875	0.2750	1.1921[c]	0.5245	0.0244	0.7487	0.4045
	(.4520)	(.5039)	(.3628)	(.3393)	(.5020)	(.3602)	(.3976)	(.2775)	(.5074)	(.5745)
Missing grade trend	0.0298	-1.7671[b]	-0.1975	-6.6562	-0.8586	-1.7119[b]	-1.1610[b]	-0.4513	0.1273	-9.0902
	(.8969)	(.8374)	(.5013)	(13.5300)	(.6475)	(.7311)	(.5822)	(.3501)	(.5672)	(14.5090)
Science hours	0.0045	-0.0002	-0.0021	0.0089	0.0030	-0.0141[b]	0.0017	-0.0082[a]	-0.0103	0.0163[a]
	(.0072)	(.0079)	(.0045)	(.0056)	(.0069)	(.0067)	(.0052)	(.0043)	(.0088)	(.0088)
Non-science hours	0.0038	0.0076	0.0011	-0.0014	0.0053	-0.0200[c]	-0.0006	0.0020	0.0012	0.0088
	(.0063)	(.0067)	(.0037)	(.0053)	(.0059)	(.0058)	(.0046)	(.0034)	(.0073)	(.0083)
Verbal MCAT	0.0070[c]	0.0082[c]	0.0058[c]	0.0067[c]	0.0063[c]	0.0022	0.0080[c]	0.0046[c]	0.0053[b]	0.0048
	(.0020)	(.0025)	(.0019)	(.0016)	(.0021)	(.0017)	(.0018)	(.0015)	(.0025)	(.0033)
Quantitative MCAT	0.0133[c]	0.0061[b]	0.0019	0.0013	0.0073[c]	0.0043[b]	0.0041[b]	0.0031[b]	-0.0007	0.0034
	(.0025)	(.0025)	(.0019)	(.0017)	(.0022)	(.0017)	(.0020)	(.0015)	(.0025)	(.0032)
General information MCAT	0.0030	-0.0022	-0.0004	0.0041[b]	0.0048[c]	0.0035[b]	0.0002	0.0037[c]	0.0020	0.0021
	(.0020)	(.0024)	(.0015)	(.0016)	(.0017)	(.0017)	(.0015)	(.0012)	(.0024)	(.0036)
Science MCAT	0.0164[c]	0.0076[c]	0.0069[c]	0.0008	0.0066[c]	0.0104[c]	0.0062[c]	0.0062[c]	0.0063[c]	0.0131[c]
	(.0021)	(.0022)	(.0016)	(.0015)	(.0018)	(.0017)	(.0016)	(.0012)	(.0023)	(.0036)
Same undergraduate school	1.5990[c]	1.3764[c]	0.8369[c]	6.3733[c]	2.4558[c]	1.1396[c]	1.0579[c]	2.6145[c]	1.2979[c]	-0.7504
	(.4823)	(.3649)	(.2690)	(.4342)	(.3380)	(.2420)	(.2639)	(.3262)	(.5004)	(.4939)
Selectivity index	1.7758[c]	2.4385[c]	1.5098[c]	-0.6045	1.5759[c]	0.8853[a]	1.7851[c]	1.6495[c]	1.7188[c]	1.2075
	(.5641)	(.4539)	(.3219)	(.5138)	(.3008)	(.4518)	(.3600)	(.2164)	(.4440)	(.8703)
Junior applicant	0.3627	0.1077	-0.3483	-0.9521	-1.6966[a]	-0.7224	-0.8238	-0.2847	-1.1174	-0.9485
	(.5164)	(.6624)	(.5417)	(.6078)	(1.0011)	(.4846)	(.5676)	(.4212)	(1.1296)	(1.3424)
Attended graduate school	-1.0236[a]	0.0514	0.0312	1.4283[c]	-0.3036	0.7380	0.0945	0.9815[c]	0.7651	0.4719
	(.5934)	(.5586)	(.3374)	(.3339)	(.6685)	(.4685)	(.3956)	(.2741)	(.5879)	(.6047)
Age	-0.1731	-0.1958[b]	0.1320[c]	-0.4994[c]	-0.4205[b]	-0.1756	-0.1076	-0.1014[a]	-0.4842[c]	-0.1140
	(.1228)	(.0919)	(.0476)	(.1154)	(.1784)	(.1104)	(.0755)	(.0565)	(.1485)	(.0988)
Female	-0.3313	0.3774	0.8541[c]	-0.6002[a]	1.3277[c]	0.5583[b]	0.3773[a]	0.6390[c]	0.2870	0.2357
	(.3055)	(.3322)	(.1927)	(.3096)	(.2159)	(.2329)	(.2036)	(.1551)	(.3057)	(.4638)
Home state resident	3.4063[c]	2.3817[c]	1.0227[c]	1.6719[c]	3.4828[c]	6.0817[c]	1.5003[c]	1.2104[c]	1.0236[c]	6.4252[c]
	(.2760)	(.3435)	(.2158)	(.3062)	(.3120)	(.9980)	(.2628)	(.1811)	(.7263)	(.8779)
Asian American	-2.0788[b]	1.1430	0.4746[a]	-0.6461	-0.1823	-0.7738	0.0970	0.4359	-6.4029	2.6721[c]
	(.9828)	(.8654)	(.2706)	(.6574)	(.6572)	(.7284)	(.2685)	(.3227)	(10.9830)	(1.0010)
Constant	-57.7880	-31.0620	-25.2650	-23.2490	-36.8140	-34.2430	-33.4860	-20.0700	-24.4210	-33.7180
Log likelihood ratio	456.4479	181.6969	157.8307	270.5421	266.3683	436.7084	251.1877	223.1624	189.0939	133.0482
R^2	0.6034	0.4551	0.2309	0.3359	0.3841	0.5273	0.3269	0.2030	0.4618	0.5594

[a]Significant at .10 level.

[b]Significant at .05 level.

[c]Significant at .01 level.

missing science GPA, *missing non-science GPA*, and *missing grade trend* and take the value of 1 when GPA values are missing on an applicant's AMCAS file; otherwise 0. This enables us to estimate the implicit GPA that an admissions committee assigns to an applicant for whom they have no undergraduate grades--often because the student attended an undergraduate school that used a "pass/fail" system.[3]

Rather than comment on the 30 separate estimated majority admissions equations (three separate equations for each of ten schools), we describe only a few general characteristics of all schools' admissions processes and identify noteworthy exceptions for particular schools or trends over time.

Undergraduate Grades

Science GPA is a highly significant ($p < .01$) factor in medical school admissions decisions for all schools in all years. Differences in the size of the *science GPA* coefficients relative to coefficients on other variables across schools indicates that some schools accord substantially more weight to this factor than others.[4] *Non-science GPA* is also considered by most schools in admissions decisions; it is a statistically significant factor ($p < .05$) in at least one year for all but one school. However, it is clearly not as important as *science GPA*.

Schools diverge considerably regarding the treatment of *missing GPA*, which often indicates an applicant attended an undergraduate school on the pass/fail system. For example, school 1 appears to judge individual cases very differently; the estimated coefficient on *missing science GPA* is large but not statistically significant. By contrast, school 5 appears to favor applicants with *missing science GPA*, imputing to them the equivalent of an excellent undergraduate record--in all three years better than a 4.0 average.[5]

Improvement in grades during undergraduate school appears to be a positive factor in admissions decisions. Although only one school shows a statistically significant coefficient on *grade trend* for all three years, it is remarkable that every coefficient on grade trend for every school in all three years is positive. This suggests that

schools favor applicants whose grades improve but that other factors may mitigate or enhance the weight accorded a record of improvement.

Amount of Undergraduate Coursework

There is no evidence that medical schools favor applicants who have completed large numbers of courses. There are almost equal numbers of positive and negative signs on the coefficients for both *science hours* and *non-science hours*, and more negative than positive coefficients are statistically significant.

At the same time, one third of the coefficients on *junior applicant* are statistically significant and negative, and the great majority of the remainder are negative. This indicates that, although medical schools do not favor applicants with large numbers of science or non-science credits, they prefer applicants who complete undergraduate coursework before entering medical school.

The treatment of course hours and junior applicants is not necessarily inconsistent. Admissions committees may be suspicious that applicants who took large numbers of course hours did so for reasons that do not reflect upon their aptitude for or commitment to medicine. For example, an applicant might take additional courses to balance lower grades on earlier courses. At the same time, the committees may also feel that most junior applicants would be better prepared and more mature with an additional year of undergraduate coursework.

At these ten medical schools, applicants who have *attended graduate school* do not appear to have significantly better or worse chances of admission than applicants as a whole. This dummy variable has statistically significant coefficients for several schools in a single year, but in every case the coefficient appears with a different sign in another year for that school, which suggests these single year effects may be statistical artifacts.

MCAT Scores

The *Science MCAT* is widely viewed as the most important of the standardized test scores used by medical school admissions committees. Our analysis confirms this general view, but there is considerable

variance across schools in the relative weights attached to the *Science MCAT*, and there are changes in the importance of the tests over time.

The *Verbal MCAT* appears to be the second ranking MCAT in terms of importance, but a word of caution is in order. When we briefed results of our analysis to admissions deans, several expressed surprise at the apparent importance of the verbal test component--one even stated that members of the committee did not routinely have access to data on the verbal score. However, these surprised admissions deans acknowledged that they felt their committees gave considerable weight to an applicant's performance during the interview, for which we have no data to measure. Thus the *Verbal MCAT* may gain its apparent importance not so much because it is used directly but rather because it is a good surrogate for verbal skills that are important in the interview.

The *Quantitative MCAT* score is close behind the verbal in terms of the overall weight it gets across the ten medical schools; in several schools its coefficient is larger than either the *Science MCAT* or *Verbal MCAT* in one of the three years. Unlike the *Verbal MCAT*, it is evaluated directly.

The *General Information MCAT* is generally the least important of the MCATs in most schools admissions decisions, although in several schools the size and statistical significance of the coefficient are greater than the verbal or quantitative MCATs in a particular year. However, the coefficient is statistically significant for all three years only in school 8.[6]

Undergraduate School Characteristics

Nine out of ten of the medical schools consistently favor applicants from the *same undergraduate school*, that is, applicants from their parent university campus.[7] However, the degree of favoritism varies sharply among the nine schools. For example, school 1 gives applicants from the same undergraduate school a preference equivalent to approximately one-fourth to one-third of one point in *Science GPA*. By contrast, in two of three years, school 4's preference for

applicants from the same campus is equal to about two full points of *Science GPA*. The two most common reasons cited by admissions deans for this preference are (1) simple loyalty to the university and (2) the fact that they can more reliably evaluate applicants from their undergraduate campus. Table 12 shows the effects of applying from the same undergraduate school on the probability of admission for an applicant whose other characteristics are one-half standard deviation above the mean.

The quality of the applicant's undergraduate school appears to be a significant factor in all ten schools' admissions decisions; 25 of 30 coefficients on *Selectivity Index* are significantly positive. Because the index has been scaled to be between zero and one using national data, the size of each coefficient shows the maximum an applicant from the most selective undergraduate school can gain over one from the least selective school. For the great majority of applicants, differences in undergraduate school selectivity are small relative to the effect of attending the undergraduate school most closely affiliated with the medical school to which they apply.

State of Residence

Residence, signifying a resident of the same state in which the medical school is located, is the only variable besides *science GPA* that is statistically significant in the 30 equations for all three years for every school. In eight of ten schools, the coefficient on *residence* increased between 1973 and 1975. Although private medical schools in our sample generally give somewhat less weight to *residence* than public schools, at least one private school is near to the top of the range in its weighting of the variable. The effect of the *residence* variable for a hypothetical applicant, alone and in combination with *same undergraduate school*, is shown in Table 12.[8]

Two of the public medical schools in our sample participate in regional agreements whereby they give preference to applicants from one or more neighboring states. In principle, first preference is given to applicants from the home state and second preference to the applicants from the state(s) with which the school has such an

Table 12

THE EFFECT OF BEING A HOME STATE APPLICANT AND ATTENDING THE SAME UNDERGRADUATE SCHOOL[a] ON ADMISSIONS PROBABILITIES FOR HYPOTHETICAL MAJORITY CANDIDATES[b]

School and Applicant Type	Probability of Admission 1973	1974	1975
School 1			
Regular	.0503	.0181	.0445
Same Undergraduate School	.2178	.0953	.1874
Home State Resident	.8609	.4533	.5843
Same Undergraduate & Home State Resident	.9702	.8261	.8743
School 2			
Regular	.0524	.0151	.0187
Same Undergraduate School	.2053	.1017	.0701
Home State Resident	.2043	.1289	.1708
Same Undergraduate & Home State Resident	.5453	.5223	.4492
School 3			
Regular	.0582	.0265	.0222
Same Undergraduate School	.1509	.0883	.0499
Home State Resident	.1103	.0794	.0594
Same Undergraduate & Home State Resident	.2628	.2350	.1274
School 4			
Regular	.0447	.0524	.0298
Same Undergraduate School	.8001	.9588	.9474
Home State Resident	.1117	.1455	.1405
Same Undergraduate & Home State Resident	.9150	.9863	.9897
School 5			
Regular	.0561	.0773	.0379
Same Undergraduate School	.5332	.5052	.3146
Home State Resident	.5240	.6421	.5617
Same Undergraduate & Home State Resident	.9549	.9562	.9373
School 6			
Regular	.0056	.0009	.0008
Same Undergraduate School	.0094	.0017	.0025
Home State Resident	.2774	.2253	.2585
Same Undergraduate & Home State Resident	.3944	.3602	.5215

Table 12--continued

School and Applicant Type	Probability of Admission 1973	1974	1975
School 7			
Regular	.0259	.0143	.0298
Same Undergraduate School[a]	.0683	.0306	.0811
Home State Resident	.1071	.0698	.1208
Same Undergraduate & Home State Resident	.2490	.1645	.2836
School 8			
Regular	.1153	.2145	.0361
Same Undergraduate School[a]	.4406	.7546	.3387
Home State Resident	.1953	.3764	.1117
Same Undergraduate & Home State Resident	.5945	.8718	.6321
School 9			
Regular	.0266	.0145	.0028
Same Undergraduate School[a]	.0423	.0542	.0102
Home State Resident	.4880	.4273	.7589
Same Undergraduate & Home State Resident	.6064	.7445	.9202
School 10			
Regular	.0112	.0169	.0033
Same Undergraduate School[a]	.0053	.0283	.0015
Home State Resident	.7206	.3821	.6680
Same Undergraduate & Home State Resident	.5485	.5112	.4871

[a]The term "same undergraduate school" is used to refer to an applicant who is attending or who has graduated from the undergraduate school most closely affiliated with the medical school to which the applicant has applied

[b]The hypothetical applicants are ones whose values are one-half a standard deviation above the mean of values for majority applicants (at the particular school) for the following variables: *Science GPA, Non-Science GPA, Science Hours, Non-Science Hours, Grade Trend,* and *Selectivity Index.* Values for the following variables are set at zero: *Missing Science GPA, Missing Non-Science GPA, Missing Grade Trend, Junior Applicant, Attended Graduate School,* and *Asian American.* Values for *Same Undergraduate School* and *Home State Resident* are set at zero for the "regular" applicant, otherwise as noted.

agreement. To estimate the effect of such preferences we included in each year in each of the two schools' admissions equations a dummy variable to denote whether an out-of-state applicant was eligible for preferential treatment by virtue of an interstate agreement. The logistic regression coefficients for these dummy variables for two schools are shown separately in Table 13 because inclusion of the coefficients in Tables 9, 10, and 11 might compromise a schools' identity. In all cases the coefficients are positive and statistically significant ($p < .01$).

To assess the effect of these agreements, we have calculated their effect on the probability of admission of a hypothetical out-of-state applicant, who would have had a .05 probability--a 1 in 20 chance--of being admitted in the absence of the agreement. The probability of admission for this hypothetical applicant from a state with which the school has an agreement is shown in the column adjacent to the coefficients for each school in each year. The estimated effects of the preference increase over the three year period for both schools. For example, we see that our hypothetical applicant's probability of admission at School A in 1973 improves from .05 in the base case to .13 when he or she applies as a resident of a preferred state; in 1975 the corresponding improvement is from .05 to .71.

Other Demograhic Factors

The preponderance of positive coefficients on the *female* variable indicates that discrimination against women applicants has effectively disappeared. Moreover, the increasing number of significant positive coefficients over the three year period suggests a trend toward favoring female applicants, other things equal.

The preponderance of negative coefficients on the *age* variable indicates that most medical schools prefer to admit applicants soon after they normally complete undergraduate school.[9] Only school 3 shows a consistent positive coefficient on *age* for all three years, which suggests a preference for older applicants. We caution against interpretation of the negative coefficients as evidence of outright

Table 13

THE EFFECT OF INTERSTATE AGREEMENT ON MAJORITY ADMISSIONS PROCESSES OF TWO PUBLIC MEDICAL SCHOOLS

	School A		School B	
Equation	Logistic Regression Coefficients[a] (standard errors in parentheses)	Probability of Admission for Hypothetical Applicant with .05 probability of Admission[b]	Logistic Regression Coefficients[c] (standard errors in parentheses)	Probability of Admission for Hypothetical Applicant with .05 probability of Admission[b]
1973 (Table 9)	1.0563[c] (.3057)	.13	2.3595[c] (.7621)	.36
1974 (Table 10)	2.0452[c] (.3499)	.29	1.9293[c] (.6975)	.27
1975 (Table 11)	3.8541[c] (.6216)	.71	3.9192[c] (.8529)	.73

[a]Maximum likelihood regression coefficient for dummy variable denoting that the applicant resides in a state that that school has agreed to give preference to. Variable has value of 1 if applicant is from such a state, otherwise 0.

[b]Estimated probability of admission for a hypothetical applicant from a state whose residents the school has agreed to give preference to and whose probability of admission in the absence of such an agreement would be .05.

[c]All coefficients are statistically significant ($p < .01$).

apparent age discrimination. Although some admissions deans and committee members state that they favor applicants who have a longer potential career, others state that their reservations about older applicants are not related to age per se, but rather that their delay in applying reflects ambivalent commitment to a medical career.

The mixture of signs on the Asian-American variable suggests that in general these applicants are not treated significantly differently from "white" or Caucasian applicants. Only school 3 appears to significantly favor Asian-American applicants.

MINORITY ADMISSIONS

There are several reasons to expect minority admissions equations to differ from the majority equations: (1) Data on the national minority applicant pool show their average scores to be well below majority averages; (2) medical school experience in evaluating minority applicants is recent and limited; (3) there are many fewer minority than majority applicants, which would be expected to decrease the predictive power of minority equations; and (4) finally, the thrust of affirmative action is to find evidence of minority applicants' suitability for the medical profession that is not reflected in the premedical characteristics that are used to evaluate majority applicants.

Examination of the summary statistics for minority applicants to the ten sample schools (Tables B.4, B.5, and B.6) shows them to have markedly lower GPAs and MCATs than majority applicants to the same schools. Although minority applicants generally attended somewhat less selective undergraduate schools than their majority counterparts at most of the ten medical schools, there were a number of exceptions to this rule at particular schools in some years.

The average accepted minority applicant had higher GPAs and MCATs and attended a more selective undergraduate school than the average rejected minority applicant at most of the ten schools in each of the three years of study. However, in 11 of 30 instances, the average rejected minority applicant to a school attended a more selective undergraduate school than the average accepted applicant. In six of 30 instances, the average accepted minority applicant had at least

one lower GPA or MCAT than the average rejected minority applicant. Moreover, in 1973 school 9 and in 1974 school 1 deviated sharply from the common pattern of admitting minority applicants who had the best undergraduate preparation for medical school, as judged by conventional standards.

The summary statistics show considerably more cases for minority than majority applicants where the average accepted applicant at a school has scores on some characteristics (GPA, MCAT, or Selectivity Index) that are inferior to those of the average rejected applicant (25 cases for minority applicants, four cases for majority applicants). This fact does not detract significantly from the importance of these conventional measures of preparation for medical school in minority admissions decisions. Moreover, the summary statistics suggest a trend toward greater attention to these conventional measures over time. Only three of the 25 exceptions appear in 1975, the last year of our data, and are in the General Information MCAT and the Selectivity Index.

Because there are few minority applicants at most of the schools, we estimate a single minority admission equation for each school, covering all three years, and we omitted some variables included in the majority analysis (see Table 14). This improves the predictive accuracy of the minority admissions equations and the precision of the estimated coefficients over what they would have been if each year's minority admissions data had been used and all variables included in the majority analysis to develop separate equations for each year. Dummy variables are used for the different years to test whether a minority applicant with all the same characteristics had a better chance of being admitted in one year than in another.

We have omitted dummy variables *missing GPA*, *junior applicant*, and *attended graduate school*, which were included in the majority equations, because of the very small number of cases in our minority data. *Grade trend* (hence *missing grade trend*) was omitted because exploratory analysis indicated it to be an insignificant factor in minority admissions. We excluded *non-science hours* for similar reasons.

Table 14

ESTIMATED ADMISSIONS EQUATIONS FOR MINORITY MEDICAL SCHOOL APPLICANTS AT TEN SCHOOLS, 1973 THROUGH 1975
(Maximum likelihood regression coefficients, standard deviations in parentheses)

Predictor Variable	School									
	1	2	3	4	5	6	7	8	9	10
Science GPA	0.8474[c]	1.4315[c]	0.6070[c]	0.8843[c]	0.9363[b]	1.5699[c]	1.0586[c]	0.5750[c]	2.2414[b]	0.8293[a]
	(.3072)	(.3806)	(.1692)	(.2256)	(.4091)	(.4425)	(.2279)	(.2076)	(.9380)	(.4758)
Non-science GPA	-0.0163	-0.2323	0.2295	0.2769	0.3089	1.1820[b]	0.3177	0.1392	1.1927	1.0796[b]
	(.2758)	(.3430)	(.1476)	(.2362)	(.3841)	(.4952)	(.1951)	(.2108)	(.9949)	(.4872)
Science hours	0.0022	-0.0197[c]	0.0001	0.0041	-0.0057	0.0019	0.0008	-0.0083[a]	0.0176	0.0083
	(.0051)	(.0068)	(.0031)	(.0039)	(.0069)	(.0081)	(.0040)	(.0045)	(.0152)	(.0086)
Verbal MCAT	0.0014	0.0038	0.0019	0.0043[c]	0.0022	0.0001	0.0023[a]	0.0002	0.0023	0.0019
	(.0022)	(.0027)	(.0012)	(.0015)	(.0027)	(.0028)	(.0014)	(.0016)	(.0065)	(.0029)
Quantitative MCAT	-0.0002	0.0013	0.0015	-0.0006	0.0064[c]	-0.0015	0.0002	0.0007	-0.0024	-0.0033
	(.0020)	(.0024)	(.0012)	(.0014)	(.0025)	(.0026)	(.0015)	(.0014)	(.0054)	(.0025)
General information MCAT	-0.0007	-0.0020	0.0006	-0.0001	0.0031	-0.0043	-0.0004	0.0020	0.0023	-0.0056
	(.0024)	(.0031)	(.0014)	(.0017)	(.0029)	(.0029)	(.0016)	(.0017)	(.0073)	(.0035)
Science MCAT	0.0037	0.0142[c]	0.0042[c]	0.0049[c]	0.0109[c]	0.0064[b]	0.0044[c]	0.0064[c]	0.0015	0.0086[c]
	(.0022)	(.0028)	(.0013)	(.0016)	(.0029)	(.0027)	(.0016)	(.0016)	(.0058)	(.0030)
Same undergraduate school	1.4305[a]	0.3524	0.0150	1.5795[b]	0.9994	0.3994	0.9910[c]	1.4355[b]	6.3514[c]	-0.7821
	(.7435)	(.6861)	(.3179)	(.6804)	(.8702)	(.5468)	(.3216)	(.6395)	(1.8077)	(.4817)
Selectivity index	0.1003	0.7106	0.8052[c]	-0.9736[a]	0.9534[b]	-0.2134	1.9632[c]	1.1523[c]	2.7095[b]	1.2198
	(.7005)	(.7670)	(.2726)	(.5722)	(.4798)	(.8518)	(.3312)	(.2836)	(1.2778)	(.8933)
Home state resident	1.6175[c]	1.7571[c]	0.7610[c]	0.5893	0.6365	4.5569[c]	0.9896[c]	0.5723[a]	5.5280	4.0124[c]
	(.3766)	(.3696)	(.1739)	(.6367)	(.4339)	(.6931)	(.2228)	(.3348)	(57.2180)	(.4866)
Black	2.1899[c]	5.2438[c]	1.3641[c]	1.3330[c]	5.0855[c]	3.6149[c]	1.1980[c]	2.1191[c]	2.5420[b]	-2.0213[a]
	(.4314)	(.6416)	(.1951)	(.2564)	(.6121)	(.6224)	(.2387)	(.2588)	(1.0229)	(1.1961)
1973	-0.5685	0.7294[a]	-0.2236	-0.6455[b]	-0.3126	1.3081[c]	-0.3433	0.2338	0.6336	0.1463
	(.4171)	(.4038)	(.1921)	(.2533)	(.4244)	(.4875)	(.2262	(.2367)	(.9419)	(.4497)
1974	0.6362[b]	-0.2088	0.0840	0.1585	0.6199	0.8520[b]	0.1632	0.9330[c]	1.0973	0.6427
	(.3140)	(.3994)	(.1938)	(.2286)	(.3774)	(.4227)	(.2326)	(.2444)	(.8343)	.4566)
Constant	-8.0371	-17.0320	-9.6968	-10.9350	-21.5150	-16.7480	-11.4370	-10.2190	-19.7620	-11.0530
Log likelihood ratio	39.2609	89.5300	94.2195	64.2325	89.5252	87.6272	98.9353	90.9850	19.8548	98.0565
R^2	0.1770	0.3943	0.1436	0.1366	0.3982	0.4399	0.1994	0.2020	0.3671	0.4729

[a]Significant at .10 level.

[b]Significant at .05 level.

[c]Significant at .01 level.

Undergraduate Grades and Coursework

Science GPA is a statistically significant ($p < .1$) factor in the minority admissions equations of all ten medical schools, and it is the most consistently important factor across all schools. By contrast, the coefficient for *non-science* GPA is statistically significant in only two of the ten school equations, although it has a positive sign in all but two instances.

Taking more science coursework does not appear to improve minority applicants' chances of being admitted. Only two schools show statistically significant coefficients for *science hours*, and both have negative signs. The absence of any consistent pattern in *science hours* coefficients for the three different majority equations for these two schools suggests that the apparent effects may be statistical artifacts.

MCAT Scores

Science MCAT is by far the most important of the standardized test scores in minority admissions decisions. The signs on all coefficients are positive, and all but two are statistically significant ($p < .05$). There are substantial differences in the relative importance of the *Science MCAT* across the ten schools, but we also observed comparable differences in the majority equations across the ten schools.

The *Verbal MCAT* is the second ranking MCAT in terms of its apparent importance in minority admissions. Although the coefficients are positive for all ten schools, only two are statistically significant ($p < .1$). Therefore, it is a distant second to the *Science MCAT*, and it may be serving largely as a proxy for verbal skills, which are useful in the interview.

Neither the *Quantitative MCAT* nor the *General Information MCAT* seems to be evaluated in any consistent manner in minority admissions decisions. None of the coefficients on either variable is statistically significant for any one of the ten schools, and there are almost equal numbers of negative and positive signs.

Undergraduate School Characteristics

With one exception, the medical schools in our sample appear to favor applicants from their parent university campus. Five of the ten coefficients on the *same undergraduate school* variable are statistically significant ($p < .1$) and positive; four others are positive. The coefficient for school 10 is negative but not statistically significant. However, two of the three signs on this variable were also negative in the majority equation, which suggests that the school may give at least slight preference to applicants from other than the parent university, regardless of their race or ethnic background. Thus, the pattern of preference--whether positive or negative--for applicants from the same undergraduate school appears to be quite similar for both minority and majority admissions processes. The effect of these preferences for hypothetical applicants whose characteristics are one-half standard deviation above the school mean are shown in Table 15.

Five of the ten schools show statistically significant preferences for minority applicants from more selective undergraduate schools, as measured by our selectivity index. Of the two cases where this variable shows negative coefficients, the one for school 4 is marginally significant ($p < .1$); and this school had one negative coefficient on the majority selectivity index variable. Thus, the school appears no better than neutral in its attitude toward applicants from more selective undergraduate schools.

State of Residence

Seven of the ten schools show statistically significant preferences for *home state resident* minority applicants, and all the coefficients on this variable have positive signs. Table 15 shows the effects of being a *home state resident* on hypothetical minority applicants.

The pattern of preferences for home state applicants is similar for minority and majority applicants. However, a comparison of Tables 12 and 15 suggests that home state resident preferences have a more pronounced effect on majority applicants than on minority

Table 15

THE EFFECT OF BEING A HOME STATE APPLICANT AND ATTENDING THE SAME UNDERGRADUATE SCHOOL[a] ON ADMISSIONS PROBABILITIES FOR HYPOTHETICAL MINORITY CANDIDATES[b]

School and Applicant Type	Probability of Admission 1973	1974	1975
School 1			
Regular	.2138	.4756	.3244
Same Undergraduate School	.5320	.7913	.6675
Home State Resident	.5782	.8205	.7076
Same Undergraduate & Home State Resident	.8514	.9503	.9101
School 2			
Regular	.4273	.2260	.2646
Same Undergraduate School	.5148	.2934	.3385
Home State Resident	.8122	.6285	.6758
Same Undergraduate & Home State Resident	.8601	.7065	.7478
School 3			
Regular	.2602	.3236	.3055
Same Undergraduate School	.2631	.3269	.3087
Home State Resident	.4295	.5059	.4849
Same Undergraduate & Home State Resident	.4331	.5096	.4886
School 4			
Regular	.0998	.1985	.1745
Same Undergraduate School	.3498	.5459	.5064
Home State Resident	.1666	.3087	.2759
Same Undergraduate & Home State Resident	.4923	.6842	.6490
School 5			
Regular	.4687	.6915	.5466
Same Undergraduate School	.7056	.8589	.7661
Home State Resident	.6250	.8090	.6950
Same Undergraduate & Home State Resident	.8191	.9200	.8609
School 6			
Regular	.0489	.0315	.0137
Same Undergraduate School	.0712	.0463	.0203
Home State Resident	.8304	.7563	.5697
Same Undergraduate & Home State Resident	.8795	.8223	.6637

Table 15--continued

School and Applicant Types	Probability of Admission 1973	1974	1975
School 7			
Regular	.1425	.2162	.1898
Same Undergraduate School	.3093	.4263	.3870
Home State Resident	.3090	.4260	.3867
Same Undergraduate & Home State Resident	.5464	.6666	.6294
School 8			
Regular	.3793	.5515	.3260
Same Undergraduate School	.7197	.8378	.6702
Home State Resident	.5200	.6855	.4616
Same Undergraduate & Home State Resident	.8199	.9016	.7827
School 9			
Regular	.1714	.2475	.0989
Same Undergraduate School	.9916	.9947	.9844
Home State Resident	.9812	.9881	.9651
Same Undergraduate & Home State Resident	1.0000	1.0000	.9999
School 10			
Regular	.0391	.0627	.0340
Same Undergraduate School	.0183	.0297	.0158
Home State Resident	.6922	.7870	.6602
Same Undergraduate & Home State Resident	.5071	.6283	.4706

[a]The term "same undergraduate school" is used to refer to an applicant who is attending or who has graduated from the undergraduate school most closely affiliated with the medical school to which the applicant has applied.

[b]The hypothetical applicants are ones whose values are one-half a standard deviation above the mean of values for minority applicants (at the particular school) for the following variables: *Science GPA*, *Non-Science GPA*, *Science Hours*, and *Selectivity Index*. Values for *Same Undergraduate School* and *Home State Resident* are set at zero for the "regular" applicant, otherwise as noted. Values for the variable *Black* are set such as to consider the hypothetical applicant in the more favorable light, i.e., *Black* is set equal to one for all schools except school 10. For school 10, *Black* equals zero.

applicants. In every instance, the hypothetical nonresident minority applicant has a higher probability of admission than the hypothetical majority counterpart. The *resident* variable always increases the probability of admission by a larger factor for the majority than for the minority applicant.

We included dummy variables in the minority equations of the two schools that have agreed formally to give preference to applicants from one or more neighboring states. We observed no statistically significant effects of these agreements on minority applicants from these states. Recall that Table 13 showed significant preferences for majority applicants from these states in all three years in both schools. However, the number of minority applicants from the subject states was so small as to preclude a meaningful test of the effects of the agreements on minority admissions.

Differential Preferences Across Minority Groups

To test whether medical schools show preference for applicants from one minority group over another, we included a dummy variable that took the value 1 if the applicant was black and 0 otherwise. For nine of the ten schools, the coefficient on this variable is positive and statistically significant ($p < .05$), denoting that black applicants are favored over members of other minority groups, other things equal. At school 10, nonblack minority applicants are accorded higher preference.

The different preferences for blacks and nonblacks appear to reflect each medical school's perception of the relative cultural and educational disadvantages of the applicants from the different minority groups who apply for admission to their school. To a lesser extent, the differences may reflect the relative political power of the different minority groups as they pertain to the affairs of any particular school.

Changes Over Time

The variables *1973* and *1974* are dummy variables indicating the minority applicant was considered for that medical school year in the

fall of 1973 or 1974. Because the default value is the entering class of 1975, the coefficients on *1973* and *1974* measure the effect of applicant year differences from the base year 1975. (A positive sign indicates that an applicant for that year had a higher probability of admission than he or she would have had if applying in 1975.)

In general, our analysis suggests that schools may have raised their standards for minority applicants in 1975 over what they were in one of the previous years. Most signs (14 of 20) on 1973 and 1974 are positive and five of the statistically significant signs are positive. Examination of the summary statistics for accepted applicants (Tables B.4, B.5, and B.6) suggests that our sample of medical schools raised their standards for minority applicants' science background (as reflected in *science GPA and science MCAT*) during the three year period.

COMPARISONS OF MAJORITY AND MINORITY ADMISSIONS PROCESSES

As a matter of policy, each of the ten medical schools studied takes some special pains to evaluate minority (and other disadvantaged) applicants in a manner that is different from the common evaluation procedures for majority applicants. Such policies operationalize affirmative action programs, and the differences between the estimated equations for minority and majority applicants confirm that stated policy is practice.

The simplest means of assessing the effect of affirmative action programs is to compare the admissions probabilities of hypothetical minority and majority applicants. From Tables 12 and 15 we have seen that hypothetical minority applicants at the same position in the distribution within a particular school's applicant pool (one-half standard deviation above the mean) almost always have a higher probability of admission than comparable majority applicants. Because the summary statistics (Appendix B Tables B.1 through B.6) show majority applicants to have consistently higher scores on average than minority applicants, we may infer that affirmative action programs quite significantly improve minority applicants' chances of admission.

For a more direct assessment of the effects of affirmative action programs in improving minority admissions probabilities, we compare the probabilities of admissions for hypothetical minority candidates and majority candidates (shown in Tables 12 and 15). Then we calculate the estimated probability of admission of a *minority* candidate if evaluated according to the *majority* admissions equation and the hypothetical *majority* candidate if evaluated according to the *minority* admissions equation. Because of the importance of being a resident of the state where the medical school is located, we present these four-way comparisons of minority and majority admissions probabilities for home state residents in Table 16 and for out-of-state residents in Table 17.

The estimated probabilities for minority and majority candidates in the two tables very clearly show the importance of affirmative action programs in facilitating minority student access to medical education. For example, in 1975, at school 1 the hypothetical home state resident *minority* applicant had a .7076 probability of being admitted if evaluated according to the minority admissions equation, but only a .0063 probability of being admitted if evaluated according to the majority equation. By contrast, the hypothetical home state resident majority applicant has a .5843 probability of admission if evaluated by majority standards, but the probability would improve to .82 if the applicant were evaluated as a minority applicant. Table 16 shows differences across years and between schools in the effects of affirmative action, but the overall picture is one of consistently strong preference for minority candidates.

Table 17 shows that, if anything, affirmative action programs make it feasible for out-of-state minority applicants to receive serious consideration for admission to some medical schools--better than a one in four chance of admission. However, if the same minority applicants were evaluated by the same standards as majority out-of-state applicants, their chances of admission would never be higher than about 1 in 70.

In sum, our analyses of admissions decisions show not only that medical schools evaluate minority applicants and majority applicants

differently, it shows that the effects of these differences greatly improve opportunities for minority access to the medical profession.

Notes to Sec. IV

[1]This inconsistency in the general pattern of relationships between applicant attributes and acceptance probabilities may be accounted for (1) by peculiarities of the scaling of the selectivity index at the lower end of Barron's selectivity continuum (see Table 8) and (2) by strong state-of-residence preferences that may lead medical schools to accept resident applicants from less selective schools and reject nonresident applicants from some selective schools.

[2]The picture on trends in undergraduate college selectivity is unclear. Because we have chosen to rescale selectivity each year on the basis of our national analysis, comparisons between years are likely to be misleading.

[3]The implicit GPA may be calculated by dividing the regression coefficient on the missing value dummy variable by the coefficient of the GPA. For example, school 2 is estimated to have assigned a value of 3.42 to a majority student with a missing science GPA (8.4454 ÷ 2.4678) in 1973, which is considerably higher than the average value of 2.959 for all applicants.

[4]Direct comparisons between coefficients on a single variable for different schools will be misleading, at best. One can calculate the estimated effect of, say, a 1.0 improvement in GPA on an applicant's odds of admission by the method shown in Section III, and this odds multiplicative factor may be compared with that of another school. However, that comparison of GPA's (or any other variable's) effect on odds will be misleading because the point of reference needs to be an applicant's "baseline" odds of admission, which differs for each school. Should the reader wish to make comparisons across schools for changes in the value of a single variable, they are probably best done using all data for two hypothetical candidates (e.g., one whose scores are at the mean) and calculating admissions probabilities. Then the effects of marginal changes in variable values can be readily estimated. Using this method, we present data showing the estimated effects of applying from the home state of the medical school and attending the same undergraduate college as the medical school.

[5]This is based on a comparison of the estimated coefficient on missing science GPA with the one on science GPA. If we divide the coefficient on missing science GPA by the coefficient on science GPA, we obtain the GPA that an average applicant with a GPA would have to obtain the same weight as the average applicant with missing science GPA. In 1973, the required GPA is 4.59 (9.6753 ÷ 2.1078). In reality this medical school's apparent preference for applicants without GPAs may be explained by the fact these applicants attended exceptionally good undergraduate schools that used pass/fail grading systems.

Table 16

COMPARISON OF ADMISSIONS PROBABILITIES FOR HYPOTHETICAL MINORITY AND MAJORITY APPLICANTS WHEN EVALUATED ACCORDING TO MINORITY AND MAJORITY EQUATIONS--HOME STATE RESIDENTS[a]

School and Applicant Type	1973 Equation		1974 Equation		1975 Equation	
	Minority	Majority	Minority	Majority	Minority	Majority
School 1						
Minority Applicant	.5782	.0511	.8205	.0054	.7076	.0063
Majority Applicant	.6750	.8609	.8847	.4533	.8200	.5843
School 2						
Minority Applicant	.8122	.0256	.6285	.0053	.6758	.0032
Majority Applicant	.9665	.2043	.9412	.1289	.9723	.1708
School 3						
Minority Applicant	.4295	.0224	.5059	.0075	.4849	.0038
Majority Applicant	.6971	.1103	.7320	.0794	.7393	.0594
School 4						
Minority Applicant	.1666	.0084	.3087	.0067	.2759	.0168
Majority Applicant	.3158	.1117	.5598	.1455	.5475	.1405
School 5						
Minority Applicant	.6250	.0853	.8090	.0601	.6950	.0201
Majority Applicant	.9389	.5240	.9775	.6421	.9680	.5617
School 6						
Minority Applicant	.8304	.0221	.7563	.0101	.5697	.0044
Majority Applicant	.9310	.2774	.9186	.2253	.8608	.2585

Table 16--continued

School and Applicant Type	1973 Equation		1974 Equation		1975 Equation	
	Minority	Majority	Minority	Majority	Minority	Majority
School 7						
Minority Applicant	.3090	.0067	.4260	.0007	.3867	.0042
Majority Applicant	.5183	.1071	.6482	.0698	.6681	.1208
School 8						
Minority Applicant	.5200	.0273	.6855	.0247	.4616	.0196
Majority Applicant	.7664	.1953	.8583	.3764	.6983	.1117
School 9						
Minority Applicant	.9812	.3295	.9881	.1618	.9651	.3206
Majority Applicant	.9943	.4880	.9973	.4273	.9917	.7589
School 10						
Minority Applicant	.6922	.1233	.7870	.0650	.6602	.0527
Majority Applicant	.8177	.7206	.8892	.3821	.8424	.6680

[a]The hypothetical minority and majority applicants are ones whose values are one half standard deviation above the mean on the following variables: *Science GPA*, *Non-Science GPA*, *Science Hours*, and *Selectivity Index*. In addition, values for majority candidates are also set one half standard deviation above the mean for *Non-Science Hours* and *Grade Trend*, which are excluded from the minority equation. Values for the following dummy variables are set at zero: *Missing Science GPA*, *Missing Non-Science GPA*, *Missing Grade Trend*, *Junior Applicant*, *Attended Graduate School*, *Asian American*, and *Same Undergraduate School*. Values for *Black* (in the Minority equation) are set such as to consider the hypothetical applicant in the most favorable light, i.e., *Black* is set equal to one for all schools except school 10. For school 10, *Black* equals *zero*. The variable *Home State Resident* takes a value of one for both majority and minority applicants.

Table 17

COMPARISON OF ADMISSIONS PROBABILITIES FOR HYPOTHETICAL MINORITY AND MAJORITY APPLICANTS WHEN EVALUATED ACCORDING TO MINORITY AND MAJORITY EQUATIONS--NONRESIDENTS[a]

School and Applicant Type	1973 Equation		1974 Equation		1975 Equation	
	Minority	Majority	Minority	Majority	Minority	Majority
School 1						
Minority Applicant	.2138	.0005	.4756	.0001	.3244	.0002
Majority Applicant	.2918	.0503	.6036	.0181	.4747	.0445
School 2						
Minority Applicant	.4273	.0056	.2260	.0006	.2645	.0003
Majority Applicant	.8326	.0524	.7341	.0151	.8581	.0187
School 3						
Minority Applicant	.2602	.0113	.3236	.0024	.3055	.0014
Majority Applicant	.4819	.0582	.5606	.0265	.5698	.0222
School 4						
Minority Applicant	.0998	.0032	.1985	.0022	.1745	.0032
Majority Applicant	.2038	.0447	.4137	.0524	.4016	.0298
School 5						
Minority Applicant	.4687	.0050	.6915	.0030	.5466	.0006
Majority Applicant	.8904	.0561	.9582	.0773	.9412	.0379
School 6						
Minority Applicant	.0489	.0003	.0315	.0000	.0137	.0000
Majority Applicant	.1241	.0056	.1058	.0009	.0609	.0008

Table 17--continued

School and Applicant Type	1973 Equation		1974 Equation		1975 Equation	
	Minority	Majority	Minority	Majority	Minority	Majority
School 7						
Minority Applicant	.1425	.0015	.2162	.0001	.1898	.0009
Majority Applicant	.2857	.0259	.4065	.0143	.4281	.0298
School 8						
Minority Applicant	.3793	.0148	.5515	.0113	.3260	.0059
Majority Applicant	.6492	.1153	.7736	.2145	.5663	.0361
School 9						
Minority Applicant	.1714	.0139	.2475	.0038	.0989	.0004
Majority Applicant	.4106	.0266	.5923	.0145	.3207	.0028
School 10						
Minority Applicant	.0391	.0006	.0627	.0019	.0340	.0001
Majority Applicant	.0750	.0112	.1268	.0169	.0882	.0033

[a]The hypothetical minority and majority applicants are ones whose values are one half standard deviation above the mean on the following variables: *Science GPA*, *Non-Science GPA*, *Science Hours*, and *Selectivity Index*. In addition values for majority candidates are also set one half standard deviation above the mean for *Non-Science Hours* and *Grade Trend*, which are excluded from the minority equation. Values for the following dummy variables are set at zero: *Missing Science GPA*, *Missing Non-Science GPA*, *Missing Grade Trend*, *Junior Applicant*, *Attended Graduate School*, *Asian American*, *Home State Resident*, and *Same Undergraduate School*. Values for *Black* (in the minority equation) are set such as to consider the hypothetical applicant in the most favorable light, i.e., *Black* is set equal to one for all schools except school 10. For school 10, *Black* equals *zero*.

[6]The general information component has been removed from a new MCAT test, which was inaugurated in 1976. The reasons cited for dropping this component include the little attention given to it in admissions decisions and the concern that the test may be culturally biased against minority applicants.

[7]Applicants are not treated as being from the same undergraduate school if they are from a different campus within a large university system. For example, an applicant to the University of California at Davis medical school from UCLA undergraduate school would not be coded as being from the same undergraduate school.

[8]See Rolph, Williams, and Lee (1978) for an analysis of the national effects of state-of-residence preferences in medical school admissions.

[9]This variable takes the value of zero for applicants 22 years or younger at the time of application, for others the difference between their actual age and 22 years. Various transformations of this variable--e.g., the natural logarithms of the variable used--were tried during exploratory analysis, but none had consistently superior explanatory power. Therefore, we chose to use the simple linear form for each in interpretation.

V. CONCLUSIONS

The processes by which medical schools admit applicants have implications for society that are much greater than admissions processes in other areas of graduate education. For many years, being admitted to medical school has been tantamount to being accepted into the medical profession because of the very low attrition rates among medical students. Thus, to a very great extent, medical school admissions committees determine who will be the nation's physicians. For most would-be doctors, these committees have absolute control over their access to a medical career; few can afford the cost of training abroad, which is a much less certain route to a medical career.

Consistent with their great responsibility to society and to individuals, U.S. medical school admissions committees take great pains in making decisions. The schools expend large resources in screening the 20 or so applications for each place, and applicants spend significant personal resources applying to multiple schools, attending interviews, etc.

The growth in medical school enrollment over the past decade has been a response to increasing interest in medical careers among undergraduates and the societal view that physicians were in short supply (a view whose validity has been questioned in recent years). However, expanded enrollment has not kept pace with interest in medical careers. There have been considerably more nominally qualified applicants in recent years than medical school places for them, and admission to medical school has become increasingly competitive.

On the one hand, this would seem to simplify the task of medical school admissions committees: They have had little difficulty selecting from among applicants a group who clearly possess the cognitive skills required of physicians. On the other hand, the plenitude of nominally qualified applicants has complicated the task of admissions committees in several important ways: Committees agonize to choose fairly among applicants whose credentials and academic preparation

for medicine are very similar. They face considerable pressure to admit particular classes of applicants--home state residents, graduates of the parent university undergraduate school, children of alumni, and so on--whose academic credentials are above the minimum acceptable threshold but below those of other applicants. The conventional admissions criteria have been increasingly questioned by a public displeased by a medical profession they hold responsible for rising health care costs, impersonal care, and failure to achieve medical breakthroughs promised by the more extravagant proponents of federal health spending. Finally, they embraced affirmative action at the very time when the places for disadvantaged minorities had to be provided at the expense of an increasingly well qualified majority applicant.

Unfortunately, no body of research on medical education offers clear guidance to admissions committees trying to make choices that serve the best interests of their own medical schools and society, and treat applicants fairly. The literature shows that, over time, measures of undergraduate achievement in science--*science GPA* and *science MCAT* scores--have been reasonably reliable predictors of student performance during medical school. Some studies show other cognitive factors that also appear to have predictive power. However, the literature in general suffers from limitations of sample size and the failure to use modern multivariate techniques.

The greater limitations of the research on the medical education process are not the predictor variables but the performance measures. Studies have examined performance during medical school, but very few students fail to perform satisfactorialy during medical school; and society's concerns are with the kinds of care it receives. There has been very little research on performance in the medical education continuum beyond medical school and even less on the performance of practicing physicians.

In general, we are more sanguine than others about both the predictive value of the preadmissions data used to screen applicants and about the relationship between medical school performance and

performance in practice. The evidence to support our optimism is scant, but few studies use reasonable sample sizes and sophisticated statistics.

To make the best case for evaluation in medical education from existing research, one must draw inferences across studies. For example, Bell (1977) found that MCATs, medical school grades, and National Board scores were statistically significant predictors of performance on the internal medicine certifying exam. In a contemporary study, Brook and Williams (1976) found that board certified physicians performed significantly better than noncertified physicians on quality of care criteria. Rolph, Williams, and Laniear (1978) found that a number of premedical school characteristics could be used in a multivariate model to predict majority and minority scores on National Board exams.

Indirect evidence of this sort is not sufficient to validate the various predictor variables and performance measures used. However, it is also not consistent with the view that medical school admissions committees waste their time in their attention to cognitive measures of preparation for a medical career.

Our empirical analysis of admissions processes is significant because it indicates that decisions of the ten schools are made in a generally consistent, predictable manner on the basis of objective criteria. Our analysis does not and could not show that the committees use the "right" criteria. Indeed, our analysis shows that the schools differ significantly in the weights they applied to various factors.

All of the schools in our sample place heavy emphasis on measures of undergraduate achievement in science, and that is consistent with the evidence on predictors of performance from entry into medical school through to specialty certifying exams.

The schools also heavily weigh other factors--being a home state resident, attending the parent university undergraduate school--that have little to do with preparation for a medical career. These considerations are easy to understand in light of political and organizational forces that the medical schools face, particularly as regards funding. However, we suspect that our analysis may show these factors

to have been even more important in admissions decisions than perceived by those who made them. For example, one school may be surprised to discover that attending undergraduate school at the parent university would improve an applicant's chances of admission more than improving science grades by a full point--say, from a B to an A average--and scoring 100 points higher on each of the four MCAT parts. A private school may be surprised that it accords preferences of almost the same magnitude to home state applicants.

The large and consistent preferences shown home state residents are particularly worthy of note. Most medical schools clearly indicate in information provided to potential applicants that they favor home state residents, and this is borne out strongly by our analysis. However, it is also the perception of some that because "everyone does it," the effects on applicants from any particular state are small. But analysis by Rolph, Williams, and Lee (1978), another study in this series, clearly shows that the consequences are sharp differences in the chances of admission for applicants who are equivalent except for their state of residence.

We believe the most significant findings of this report are those pertaining to affirmative action. In the 1960s and early 1970s, academic medicine was often chastised for discrimination against women in admissions decisions and for its failure to provide medical education opportunities for disadvantaged minority groups. Our analysis shows that discrimination against female applicants has disappeared and that, if anything, women are preferred applicants at many schools. Comparisons of the admissions processes for majority and minority applicants clearly demonstrate that all schools in our sample have strong affirmative action programs. All the schools admit minority applicants who would have had little or no chance of admission if judged by majority criteria.

Our analysis of the ten schools' minority admissions processes shows that they have not only relaxed standards for minority applicants but weighted criteria differently than in majority decisions. Their purpose in applying different weights may be to avoid measures believed to be "culturally biased." For whatever reason, science

achievement measures--science GPA and science MCAT--are given consistently very heavy weight by all schools in choosing among minority applicants, but the more general aptitude tests of quantitative MCAT and verbal MCAT scarcely appear to be used to evaluate minority applicants. However, Rolph, Williams, and Laniear (1978) indicate that these general aptitude measures are in some cases equal or better predictors of minority performance on National Board exams, the most widely used evaluation instruments in medical education. This suggests admissions committees may have better means at their disposal for selecting minority applicants than they are currently using.

In this report and others in the series, we have elaborated statistical methods that can be used to analyze medical school admissions and medical school performance. Although we believe our uses of these methods have provided significant new insights to medical education research, their value will diminish sharply over time if similar analyses are not replicated with new data. As a first step, analysis needs to be performed using the *new MCAT*, which was designed precisely to overcome deficiencies of the test used in our series of studies. Clearly, better measures of performance in medicine need to be developed, but there is still much to be learned from analysis of currently used measures. To be effective, such analysis must deal with populations that are large enough to permit the use of powerful multivariate statistical techniques, and this means gathering data from multiple schools, as we have done.

Finally, we recognize that we have omitted important factors from our analyses. Our research emphasizes measures of a would-be physician's knowledge or capacity to learn. These are important for good medical care, but the diligence and sensitivity with which a physician provides care may be equally important to good medical outcomes. Medical school admissions committees are very concerned with these attributes when choosing among otherwise well-qualified applicants, and the effort that goes into interviewing candidates reflects this concern. It should be the highest priority for researchers in this area to deal more analytically with the noncognitive attributes and predictors of good medical care.

Appendix A

SELECTING SCHOOLS FOR A STUDY OF ACADEMIC MEDICAL CENTERS

Ten U.S. medical schools were subjects of a study of the effects of federal programs on academic medical centers. These ten schools were selected in a two stage process, which is briefly described below. A more complete description of the selection process is contained in Williams et al. (forthcoming).

The ten school study was conducted in two phases. In the first phase, begun in early 1972, five medical schools--three public and two private schools--agreed to participate in the study. These five schools were chosen for their diversity on the basis of advice from knowledgeable people within the Department of Health, Education, and Welfare and the Association of American Medical Colleges. One of the schools served as the pilot school for the first phase analysis.

In the second phase of the study, begun in late 1972, a method was developed for clustering medical schools according to their multiple characteristics. The first step in the clustering process was to collect data on all 94 U.S. medical schools that had awarded M.D. degrees in 1972. Data on 31 variables were obtained from various sources as shown in Table A.1. In the second step we collapsed these data into six synthetic dimensions, using factor analysis. The number of factors was chosen on the basis of explained variance and intuitive appeal. Table A.2 shows the six factors and the variables highly correlated with them. Each medical school therefore has a factor score on each of six factors. The number of characteristics describing medical centers has therefore been reduced to six, and each center is represented in a six-dimensional space by its factor score coordinates. Schools that are close together in this space are judged to be similar, and those that are far apart are judged to be dissimilar.

In the third step a simple algorithm divides the centers into "clusters" of neighboring points so that the sum of the squared

Table A.1

VARIABLES USED IN FACTOR ANALYSIS

Variable No.	Data	Sources
1	Medical students	[1]
2	Interns in major teaching hospitals	[1,2]
3	Residents in major teaching hospitals	[1,2]
4	State (1) or private (0) school status	[1]
5	Unrestricted endowment (decile)	[3]
6	MCAT science scores (decile)	[3]
7	Percent faculty salary from federal dollars (decile)	[3]
8	State Medicaid program	[5]a
9	Percent NIH research applications approved	[5]
10	Average priority score	[5]
11	Population SMSA/total medical students SMSA	[1,6]
12	NIH research and training grant dollars (FY 1971)	[4]
13	Total students	[1]
14	Percent of medical students from home state	[1]
15	Special project dollars/total students	[1,7]
16	Log (1972--year organized)	[1]
17	Percent of total beds in university hospital	[2]
18	Percent total beds in VA hospital	[2]
19	Part-time faculty/full-time faculty	[3]
20	Volunteer faculty/full-time faculty	[3]
21	Full-time faculty/total students	[1,3]
22	Sponsored program expenditures/full-time faculty	[3]
23	Regular operating expenditures/total students	[1,3]
24	Total expenditures/total students	[1,3]
25	Sponsored program expenditures/total expenditures	[3]
26	(Interns and residents)/medical students	[1,2]
27	(Masters and doctors in basic science)/medical students	[1]
28	Financial distress dollars/regular operating expenditures	[3,7]

Table A.1--continued

Variable No.	Data	Sources
29	Dollars weighted priority score - priority score	[5]
30	Dollars weighted fraction approved - fraction approved	[5]
31	Other student equivalents/medical students	[1]

SOURCES: [1] Council on Medical Education, American Medical Association, *Medical Education in the United States, 1970-1971*, Chicago, 1971.

[2] American Medical Association, *Directory of Approved Internships and Residencies, 1971-1972*, Chicago, 1971.

[3] Unpublished data from the Association of American Medical Colleges.

[4] Unpublished data from the Division of Research Grants, National Institutes of Health.

[5] Social Rehabilitation Service, Department of Health, Education, and Welfare, *Medicaid Services by State*, March 1971.

[6] U.S. Census Bureau, Standard Metropolitan Statistical Areas.

[7] Unpublished data from the Bureau of Health Manpower Education, National Institutes of Health.

[a]State Medicaid programs are divided into three groups and coded as follows: states with no program (0), states that offer Medicaid to people receiving federally supported financial assistance (1), and states that also offer Medicaid to people eligible for medical but not for financial assistance (2).

Table A.2

SIX FACTORS DESCRIBING ACADEMIC HEALTH CENTERS[a]

Factor 1	Federal Research Involvement
	NIH research and training grant dollars (FY 1971)
	Sponsored program expenditures/full-time faculty
	Percent NIH research applications approved
	(-) average priority score[b]
	Total expenditures/total students
	Sponsored program expenditures/total expenditures
	Residents in major teaching hospitals
	Interns in major teaching hospitals
Factor 2	Graduate Medical Education Emphasis
	State Medicaid program
	(-) MCAT science scores (decile)
	(Interns & residents)/medical students
	(-) percent of total beds in VA hospital
	Interns in major teaching hospitals
	Residents in major teaching hospitals
Factor 3	Size of Undergraduate Medical Education Program
	Medical students
	Log (1972 -- year organized)
	Total students
	(-) regular operating expenditures/total students
	(-) full-time faculty/total students
Factor 4	Reliance on Non-full-time Faculty
	Volunteer faculty/full-time faculty
	Population SMSA/total medical students SMSA
	(-) percent of total beds in university hospital
Factor 5	Dependence on Federal Support
	Percent faculty salary from federal dollars (decile)
	Financial distress dollars/regular operating expenditures
	(-) percent of medical students from home state
	Special project dollars/total students
	(-) state (1) or private (0) school status
	Sponsored program expenditures/total expenditures
Factor 6	Non M.D. Education Program Intensity
	Other student equivalents/medical students
	(Masters and doctors in basic science/medical students

[a]Variables under each factor are listed in the order of their loading on that factor. All variables listed have loadings of 0.5 or higher. A minus sign indicates a negative correlation.

[b]Lower scores are better.

distances from each point to the centroid of its cluster is minimized. The number of clusters must be selected in advance. The clusters. represent groups of centers that are similar with respect to the data we gathered. The clustering was an aid in the selection of representative schools. That is, by selecting centers from the different clusters, we expected to achieve enough variation to have covered the major types of U.S. academic health centers.

Because factor analysis and cluster analysis necessarily involve some arbitrary decisions, we chose to enlist expert advice in the actual choice of centers. We consulted several individuals at the National Institutes of Health and the Association of American Medical Colleges who were familiar with a large number of centers to get their opinions regarding the interpretability of the six factors or synthetic dimensions and to enlist their advice in the selection of sample centers from ten clusters (see Table A.3).[1]

In enlisting advice on choice of a sample, we first asked each individual separately to indicate any center that did not seem to "belong" with the other centers in the cluster. There was a high degree of consensus among the six individuals we asked to perform this exercise. On this basis, we excluded about ten centers from consideration, as a result of which no centers were chosen from clusters 2 and 6.[2] Then we asked for advice on the final selection of five centers to add to the original group of five. Finally, our selected group of ten was approved by our research sponsors in the Department of Health, Education, and Welfare.

Notes to Appendix A

[1]Several different clusters were presented to our consultants for their comments. The clusters shown in Table A.3 are the most refined set, developed after minor errors in the data were discovered and corrected.

[2]Besides being small, these were the least tightly grouped of the ten clusters as indicated the large mean distances (2.69, 3.14) of centers from the cluster centroids.

Table A.3

TEN CLUSTERS ON SIX FACTORS[a]

Cluster #1 of 13 centers: m.d. = 1.69[b]

Oregon
Ohio State
Colorado
Kentucky
Louisiana, New Orleans
Tennessee
Minnesota
Medical College of Georgia
Arkansas
Kansas
Texas, Southwestern
Suny, Buffalo
Indiana

Cluster #2 of 5 centers: m.d. = 2.69

UC-Davis
Michigan State
Louisiana, Shreveport
UC-Irvine
Mount Sinai

Cluster #3 of 11 centers: m.d. = 2.08

Medical College of Virginia
Maryland
Medical College of Wisconsin
Northwestern
Wayne State
Suny, Downstate
Hahnemann
Thomas Jefferson
Illinois
Loma Linda
University of Michigan

Cluster #4 of 10 centers: m.d. = 2.53

Case Western
Columbia
University of Pennsylvania
New York University
UC-Los Angeles
UC-San Francisco
Harvard
Yeshiva, Einstein
University of Washington
University of Southern California

Cluster #5 of 13 centers: m.d. = 1.36

Oklahoma
Puerto Rico
Vermont
South Carolina
University of Virginia
Mississippi
University of North Carolina
Louisville
Missouri
Nebraska
West Virginia
Iowa
University of Wisconsin

Cluster #6 of 3 centers: m.d. = 3.14

Medical College of Ohio
UC-San Diego
Arizona

Cluster #7 of 12 centers: m.d. = 1.53

Pittsburgh
Cincinnati
New Jersey Medical School
Temple
Suny, Upstate
Bowman Gray
Miami
Florida, Gainesville
Cornell
Texas, Galveston
Texas, San Antonio
Pennsylvania State

Cluster #8 of 10 centers: m.d. = 1.36

Yale
Washington, St. Louis
Emory
Johns Hopkins
Stanford
Duke
Vanderbilt
Rochester
Baylor
University of Chicago

Cluster #9 of 13 centers: m.d. = 2.20

Tulane
Georgetown
Medical College of Pennsylvania
Boston University
Loyola, Chicago
Albany
Saint Louis
New York Medical
Chicago Medical
Tufts
Howard
George Washington
Creighton

Cluster #10 of 4 centers: m.d. = 1.58

Utah
Alabama
University of New Mexico
Meharry

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[a] Factors 4 and 6 shown in Table A.2 were given only half the weight of other factors in clustering of centers.

[b] The mean distance of schools in each cluster to the controid of their cluster is shown on the first line of each cluster as "m.d. = ____."

Appendix B

SUMMARY STATISTICS
FOR APPLICANTS AT TEN MEDICAL SCHOOLS,
1973, 1974, 1975

Table B.1

MEAN AND STANDARD DEVIATIONS, MAJORITY, 1973

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	3.573	3.170	3.510	3.601	3.576	3.561	3.646	3.450	3.220	3.471
	(0.299)	(0.653)	(0.527)	(0.276)	(0.500)	(0.334)	(0.351)	(0.518)	(0.411)	(0.383)
Rejected	3.019	2.935	3.151	3.003	3.154	2.978	3.153	3.128	3.022	2.974
	(0.406)	(0.511)	(0.553)	(0.459)	(0.537)	(0.463)	(0.467)	(0.515)	(0.487)	(0.525)
Total	3.066	2.959	3.172	3.028	3.180	3.081	3.189	3.159	3.036	3.019
	(0.427)	(0.531)	(0.558)	(0.469)	(0.544)	(0.496)	(0.477)	(0.524)	(0.485)	(0.533)
Non-Science GPA										
Accepted	3.457	3.133	3.460	3.544	3.512	3.538	3.581	3.401	3.190	3.445
	(0.362)	(0.675)	(0.522)	(0.300)	(0.474)	(0.328)	(0.354)	(0.511)	(0.396)	(0.455)
Rejected	3.149	3.040	3.176	3.135	3.209	3.138	3.222	3.188	3.118	3.101
	(0.423)	(0.486)	(0.538)	(0.435)	(0.507)	(0.440)	(0.444)	(0.483)	(0.425)	(0.493)
Total	3.176	3.050	3.193	3.153	3.227	3.212	3.248	3.209	3.123	3.132
	(0.427)	(0.508)	(0.541)	(0.438)	(0.510)	(0.452)	(0.448)	(0.490)	(0.423)	(0.499)
Verbal MCAT										
Accepted	583.687	571.748	621.857	585.256	627.537	562.944	634.136	629.144	585.100	592.778
	(78.512)	(79.759)	(74.678)	(72.417)	(70.057)	(72.423)	(61.945)	(71.035)	(87.819)	(85.656)
Rejected	556.136	527.461	581.557	539.793	573.129	529.362	568.808	582.014	567.081	544.750
	(80.281)	(87.435)	(86.903)	(82.751)	(83.897)	(81.886)	(83.471)	(79.866)	(83.989)	(89.430)
Total	558.484	531.926	583.932	541.723	576.394	535.315	573.499	586.670	568.311	549.054
	(80.487)	(87.682)	(86.741)	(82.843)	(84.121)	(81.287)	(83.826)	(80.271)	(84.348)	(90.091)
Quantitative MCAT										
Accepted	663.185	630.528	640.886	638.259	664.602	622.979	664.136	663.895	605.900	634.206
	(60.137)	(81.785)	(71.985)	(59.605)	(55.180)	(70.464)	(52.514)	(65.126)	(70.397)	(69.568)
Rejected	593.745	571.873	609.198	575.493	612.576	571.164	602.310	609.797	590.824	564.609
	(75.745)	(87.483)	(84.449)	(82.749)	(81.787)	(84.270)	(78.827)	(80.048)	(85.285)	(91.692)
Total	599.661	577.787	611.066	578.157	615.699	580.349	606.749	516.142	591.853	570.846
	(77.015)	(88.671)	(84.087)	(82.869)	(81.376)	(84.328)	(78.863)	(80.331)	(84.418)	(92.066)
General Information MCAT										
Accepted	582.490	575.976	597.171	572.252	621.02[illegible]	570.575	600.000	616.547	575.400	587.698
	(70.942)	(78.724)	(75.687)	(62.441)	(74.733)	(68.645)	(69.987)	(74.635)	(72.417)	(76.669)
Rejected	555.820	535.246	563.851	539.322	569.682	536.547	553.179	574.927	560.927	538.609
	(73.072)	(73.104)	(81.717)	(73.352)	(76.813)	(72.345)	(75.829)	(77.190)	(77.557)	(77.178)
Total	558.092	539.352	565.815	540.720	572.764	542.579	556.540	579.039	561.915	543.009
	(73.261)	(74.671)	(81.740)	(73.220)	(77.764)	(72.852)	(76.377)	(77.927)	(77.280)	(78.345)
Science MCAT										
Accepted	636.892	608.577	641.457	626.725	653.010	606.847	661.864	645.580	558.800	623.889
	(57.721)	(62.648)	(62.735)	(53.877)	(57.350)	(54.967)	(53.479)	(59.708)	(70.206)	(62.633)
Rejected	578.783	545.811	591.528	555.782	586.769	541.877	584.353	589.394	564.956	541.750
	(67.111)	(82.433)	(82.671)	(76.893)	(79.969)	(78.668)	(74.066)	(76.310)	(80.28[illegible])	(84.962)
Total	583.734	552.139	594.471	558.794	590.745	553.394	589.918	594.945	566.584	549.111
	(68.309)	(82.824)	(82.465)	(77.388)	(80.345)	(79.000)	(75.477)	(76.683)	(79.841)	(86.420)
Selective Index										
Accepted	0.291	0.235	0.460	0.277	0.545	0.408	0.399	0.599	0.576	0.279
	(0.277)	(0.350)	(0.323)	(0.280)	(0.338)	(0.385)	(0.291)	(0.345)	(0.374)	(0.379)
Rejected	0.289	0.215	0.346	0.249	0.393	0.320	0.296	0.443	0.384	0.213
	(0.288)	(0.285)	(0.308)	(0.290)	(0.339)	(0.360)	(0.278)	(0.337)	(0.330)	(0.302)
Total	0.289	0.217	0.352	0.250	0.402	0.335	0.303	0.459	0.397	0.219
	(0.289)	(0.292)	(0.310)	(0.290)	(0.341)	(0.366)	(0.280)	(0.341)	(0.337)	(0.310)

Table B.2

MEAN AND STANDARD DEVIATIONS, MAJORITY, 1974

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	3.679	3.353	3.664	3.579	3.636	3.604	3.745	3.554	3.408	3.512
	(0.237)	(0.647)	(0.346	(0.293)	(0.429)	(0.289)	(0.262)	(0.394)	(0.390)	(0.350)
Rejected	3.130	3.033	3.274	3.213	3.256	3.090	3.238	3.181	3.151	3.063
	(0.413)	(0.491)	(0.454)	(0.429)	(0.482)	(0.464)	(0.442)	(0.478)	(0.468)	(0.479)
Total	3.162	3.054	3.293	3.132	3.278	3.152	3.271	3.219	3.167	3.095
	(0.425)	(0.509)	(0.458)	(0.434)	(0.488)	(0.477)	(0.450)	(0.484)	(0.468)	(0.485)
Non-Science GPA										
Accepted	3.606	3.335	3.562	3.562	3.569	3.596	3.703	3.519	3.331	3.464
	(0.295)	(0.660)	(0.423)	(0.325)	(0.442)	(0.316)	(0.277)	(0.396)	(0.436)	(0.430)
Rejected	3.266	3.134	3.317	3.247	3.303	3.227	3.296	3.260	3.215	3.147
	(0.414)	(0.484)	(0.443)	(0.430)	(0.458)	(0.447)	(0.438)	(0.461)	(0.433)	(0.472)
Total	3.286	3.148	3.329	3.261	3.319	3.272	3.322	3.286	3.222	3.170
	(0.414)	(0.500)	(0.445)	(0.431)	(0.462)	(0.449)	(0.441)	(0.461)	(0.434)	(0.476)
Verbal MCAT										
Accepted	586.565	580.816	626.795	592.407	625.348	564.755	626.031	624.375	587.752	585.667
	(71.473)	(87.566)	(59.719)	(67.491)	(61.785)	(72.011)	(58.412)	(62.586)	(77.673)	(79.764)
Rejected	553.890	527.717	573.870	540.127	527.075	528.713	563.900	569.575	559.569	539.929
	(80.995)	(87.710)	(83.734)	(82.321)	(79.110)	(82.800)	(84.069)	(80.619)	(85.567)	(87.786)
Total	555.828	531.346	576.428	542.305	575.209	533.116	567.968	575.096	561.330	543.208
	(80.823)	(88.688)	(831504)	(82.417)	(79.189)	(82.394)	(84.045)	(80,686)	(85.347)	(87.967)
Quantitative MCAT										
Accepted	661.174	633.265	652.487	642.441	656.045	625.350	673.475	657.813	635.459	612.833
	(46.672)	(53.458)	(59.103)	(53.374)	(48.191)	(58.985)	(40.752)	(49.034)	(59.603)	(77.549)
Rejected	596.420	576.347	611.272	580.944	616.796	578.976	607.736	606.478	589.716	567.587
	(71.965)	(80.942)	(75.134)	(76.664)	(70.875)	(80.327)	(73.801)	(74.184)	(79.174)	(84.183)
Total	600.262	580.237	613.265	583.507	619.106	584.641	612.041	611.650	592 575	570.830
	(72.349)	(80.644)	(74.956)	(76.823)	(70.349)	(79.488)	(73.909)	(73.682)	(78.863)	(84.492)
General Information MCAT										
Accepted	584.565	583.463	595.205	579.714	607.836	569.266	592.713	615.142	583.073	563.667
	(57.272)	(77.968)	(69.401)	(63.904)	(69.881)	(67.491)	(64.937)	(63.378)	(68.603)	(74.844)
Rejected	550.144	532.246	557.344	536.530	564.709	531.793	547.017	561.313	553.667	532.439
	(74.826)	(74.819	(79.977)	(73.877)	(74.525	(74.363)	(78.526)	(75.264)	(75.645)	(77.079)
Total	562.185	535.746	559.175	538.330	567.247	536.371	550.009	566.736	555.505	534.677
	(74.835)	(76.117)	(79.905)	(73.990)	(74.941)	(74.562)	(78.518)	(75.895)	(75.743)	(77.299)
Science MCAT										
Accepted	661.913	633.163	658.179	637.088	655.099	631.629	682.489	656.534	610 229	603.833
	(47.731)	(58.791)	(53.594)	(57.531)	(55.209)	(41.613)	(36.724)	(52.796)	(67.695)	(65.796)
Rejected	585.995	556.085	602.731	567.613	600.283	558.562	596.103	593.222	575.685	549.363
	(72.035)	(85.489)	(76.538)	(77.933)	(75.526)	(80.516)	(75.537)	(76.426)	(79.658)	(84.259)
Total	590.499	561.353	605.412	570.509	603.508	567.367	601.759	599.601	577.844	553.268
	(73.058)	(86.416)	(76.514)	(78.426)	(75.587)	(80.699)	(76.661)	(76.783)	479.388)	(84.222)
Selective Index										
Accepted	0.282	0.266	0.413	0.286	0.544	0.411	0.371	0.600	0.518	0.172
	(0.283)	(0.354)	(0.296	(0.287)	(0.323)	(0.374)	(0.262)	(0.345)	(0.353)	(0.302)
Rejected	0.296	0.226	0.328	0.267	0.408	0.311	0.294	0.414	0.286	0.235
	(0.287)	(0.291)	(0.297)	(0.298)	(0.339)	(0.345)	(0.271)	(0.326)	(0.333)	(0.311)
Total	0.295	0.229	0.332	0.268	0.416	0.323	0.299	0.433	0.394	0.231
	(0.287)	(0.296)	(0.297)	(0.297)	(0.339)	(0.350)	(0.271)	(0.322)	(0.335)	(0.319)

Table B.3

MEAN AND STANDARD DEVIATIONS, MAJORITY, 1975

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	3.701	3.426	3.671	3.479	3.678	3.639	3.714	3.484	3.433	3.541
	(0.238)	(0.580)	(0.305)	(0.382)	(0.391)	(0.297)	(0.295)	(0.386)	(0.342)	(0.349)
Rejected	3.191	3.118	3.327	3.171	3.260	3.143	3.302	3.277	3.152	3.101
	(0.392)	(0.472)	(0.437)	(0.423)	(0.525)	(0.439)	(0.432)	(0.417)	(0.449)	(0.473)
Total	3.234	3.138	3.342	3.179	3.278	3.221	3.328	3.286	3.166	3.132
	(0.407)	(0.486)	(0.437)	(0.425)	(0.527)	(0.457)	(0.436)	(0.418)	(0.449)	(0.479)
Non-Science GPA										
Accepted	3.636	3.338	3.558	3.521	3.587	3.676	3.662	3.464	3.417	3.460
	(0.280)	(0.605)	(0.380)	(0.345)	(0.398)	(0.265)	(0.309)	(0.369)	(0.320)	(0.358)
Rejected	3.339	3.243	3.372	3.311	3.317	3.308	3.363	3.360	3.248	3.239
	(0.377)	(0.458)	(0.422)	(0.407)	(0.507)	(0.404)	(0.416)	(0.394)	(0.411)	(0.453)
Total	3.365	3.249	3.380	3.316	3.329	3.365	3.382	3.364	3.256	3.255
	(0.379)	(0.470)	(0.422)	(0.407)	(0.506)	(0.408)	(0.417)	(0.393)	(0.409)	(0.451)
Verbal MCAT										
Accepted	592.330	595.741	632.738	575.747	634.882	578.278	630.097	631.130	598.529	592.879
	(70.082)	(63.285)	(58.450)	(64.799)	(56.347)	(72.129)	(52.263)	(58.467)	(70.874)	(84.189)
Rejected	553.922	543.391	580.777	549.485	575.946	539.154	577.333	576.462	558.897	547.445
	(79.976)	(83.743)	(79.165)	(81.547)	(79.766)	(82.253)	(78.271)	(77.950)	(83.398)	(88.664)
Total	557.181	546.806	583.137	550.173	578.535	545.288	580.665	578.618	560.796	550.686
	(79.893)	(83.554)	(79.081)	(81.257)	(79.798)	(81.976)	(77.948)	(78.001)	(83.258)	(89.081)
Quantitative MCAT										
Accepted	663.235	647.593	660.238	613.966	671.627	640.351	671.117	657.337	623.235	623.939
	(45.298)	(48.825)	(54.662)	(59.933)	(45.876)	(56.278)	(46.805)	(55.396)	(60.385)	(59.566)
Rejected	606.439	589.593	624.145	594.314	625.772	586.878	622.199	618.475	596.794	575.640
	(70.241)	(79.357)	(70.249)	(73.268)	(71.253)	(76.597)	(69.045)	(68.317)	(75.811)	(83.430)
Total	611.260	593.376	625.784	594.828	627.784	595.220	625.288	620.008	597.489	579.086
	(70.277)	(79.031)	(70.016)	(73.013)	(70.952)	(76.294)	(68.887)	(68.271)	(75.354)	(82.872)
General Information MCAT										
Accepted	561.425	556.759	585.238	548.851	602.337	557.274	577.136	603.199	567.843	571.212
	(69.742)	(71.641)	(78.397)	(63.077)	(68.204)	(68.106)	(70.298)	(69.211)	(66.293)	(77.455)
Rejected	537.069	528.902	550.438	532.880	551.599	552.336	546.031	553.447	542.361	534.290
	(71.966)	(73.022)	(75.517)	(71.800)	(72.953)	(71.500)	(73.363)	(73.363)	(74.148)	(77.395)
Total	539.136	530.719	552.018	533.298	553.826	530.343	547.995	555.410	543.581	536.924
	(72.088)	(73.236)	(75.985)	(71.626)	(73.482)	(71.906)	(73.553)	(73.836)	(73.977)	(77.940)
Science MCAT										
Accepted	674.412	643.333	675.536	605.690	678.550	640.552	683.883	660.479	616.569	628.182
	(63.933)	(69.826)	(57.993)	(64.768)	(61.415)	(60.987)	(62.479)	(66.247)	(71.874)	(70.234)
Rejected	596.049	568.779	617.087	580.368	612.226	567.152	613.855	608.364	582.750	561.973
	(76.130)	(85.970)	(78.717)	(79.687)	(82.453)	(80.326)	(77.973)	(77.707)	(82.867)	(88.466)
Total	602.700	573.641	619.742	581.031	615.138	578.660	618.277	610.419	584.371	566.697
	(78.271)	(86.964)	(78.835)	(79.431)	(82.761)	(82.062)	(78.939)	(77.946)	(82.675)	(88.910)
Selective Index										
Accepted	0.251	0.299	0.394	0.245	0.513	0.445	0.368	0.579	0.495	0.232
	(0.224)	(0.342)	(0.267)	(0.275)	(0.316)	(0.394)	(0.259)	(0.341)	(0.353)	(0.352)
Rejected	0.280	0.231	0.300	0.251	0.391	0.293	0.285	0.357	0.345	0.199
	(0.271)	(0.294)	(0.280)	(0.289)	(0.336)	(0.341)	(0.265)	(0.317)	(0.317)	(0.290)
Total	0.277	0.235	0.304	0.251	0.396	0.317	0.290	0.366	0.352	0.201
	(0.268)	(0.297)	(0.280)	(0.289)	(0.336)	(0.354)	(0.265)	(0.320)	(0.320)	(0.295)

Table 3.4

MEAN AND STANDARD DEVIATIONS, MINORITY, 1973

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	3.016	2.830	3.072	3.159	2.968	2.759	3.347	2.935	2.920	3.216
	(0.742)	(0.602)	(0.526)	(0.475)	(0.667)	(0.734)	(0.430)	(0.577)	(0.439)	(0.459)
Rejected	2.870	2.419	2.774	2.653	2.780	2.599	2.808	2.690	2.820	2.541
	(0.597)	(0.596)	(0.631)	(0.583)	(0.658)	(0.580)	(0.581)	(0.635)	(0.697)	(0.570)
Total	2.876	2.464	2.819	2.670	2.794	2.621	2.859	2.723	2.824	2.653
	(0.603)	(0.609)	(0.625)	(0.586)	(0.659)	(0.603)	(0.590)	(0.632)	(0.685)	(0.607)
Non-Science GPA										
Accepted	3.069	3.148	3.210	3.254	3.275	3.042	3.333	3.275	3.270	3.191
	(0.487)	(0.454)	(0.414)	(0.461)	(0.490)	(0.585)	(0.318)	(0.423)	(0.269)	(0.530)
Rejected	3.038	2.748	3.027	2.936	3.023	2.852	3.039	3.031	2.950	2.825
	(0.458)	(0.520)	(0.479)	(0.479)	(0.505)	(0.515)	(0.484)	(0.465)	(0.542)	(0.477)
Total	3.040	2.792	3.055	2.947	3.043	2.879	3.066	3.064	2.966	2.886
	(0.458)	(0.528)	(0.474)	(0.482)	(0.508)	(0.527)	(0.478)	(0.467)	(0.536)	(0.503)
Verbal MCAT										
Accepted	529.000	469.615	539.557	519.444	547.353	448.529	561.800	538.878	438.333	470.455
	(110.975)	(82.328)	(4.703)	(82.431)	(73.360)	(121.960)	(90.519)	(98.294)	(73.711)	(90.434)
Rejected	495.311	440.859	504.030	469.080	499.486	473.095	496.329	508.754	481.567	450.265
	(98.852)	(82.210)	(102.590)	(96.938)	(99.201)	(100.509)	(98.508)	(101.723)	(101.258)	(91.064)
Total	496.570	444.196	509.105	470.716	503.009	469.672	502.238	512.787	479.714	453.529
	(99.449)	(88.745)	(102.179)	(96.871)	(98.208)	(103.550)	(99.524)	(101.659)	(100.213)	(90.885)
Quantitative MCAT										
Accepted	526.000	480.000	571.203	549.074	590.882	505.588	598.200	569.285	538.333	530.909
	(120.678)	(85.709)	(100.209)	(95.927)	(83.820)	(108.482)	(90.293)	(88.553)	(122.202)	(87.813)
Rejected	556.762	464.596	533.861	505.137	537.430	502.333	535.587	542.013	556.791	471.228
	(114.104)	(108.346)	(108.851)	(106.614)	(106.866)	(102.049)	(106.188)	(110.044)	(123.447)	(83.776)
Total	552.246	466.384	539.195	505.564	541.364	502.787	542.148	546.530	556.000	480.887
	(114.807)	(105.916)	(108.365)	(106.516)	(106.116)	(102.510)	(106.259)	(107.682)	(122.571)	(86.952)
General Information MCAT										
Accepted	518.000	453.846	520.823	521.667	527.353	460.294	538.200	527.041	435.000	505.909
	(102.637)	(59.553)	(83.890)	(61.457)	(74.122)	(83.890)	(78.751)	(90.392)	(98.489)	(84.172)
Rejected	493.290	446.667	495.464	475.535	497.664	480.143	489.742	505.221	487.687	454.474
	(85.047)	(79.738)	(83.315)	(81.289)	(86.475)	(85.935)	(91.198)	(90.247)	(92.369)	(70.017)
Total	494.507	447.500	499.087	477.034	499.848	477.377	494.116	508.142	485.429	462.794
	(85.866)	(77.587)	(83.793)	(81.106)	(85.835)	(83.390)	(82.096)	(90.449)	(92.508)	(74.612)
Science MCAT										
Accepted	548.000	486.538	550.570	534.630	560.882	450.294	579.600	551.531	495.000	521.818
	(116.242)	(93.368)	(87.042)	(88.033)	(69.826)	(122.786)	(67.073)	(75.182)	(115.326)	(79.665)
Rejected	519.301	427.071	506.730	475.448	504.439	469.667	502.183	503.549	499.358	436.754
	(96.726)	(94.950)	(106.133)	(97.688)	(103.704)	(86.914)	(101.670)	(102.441)	(111.227)	(87.969)
Total	520.714	433.973	512.993	477.371	508.593	466.967	509.170	509.973	493.429	450.515
	(97.640)	(96.468)	(104.183)	(97.905)	(102.553)	(92.367)	(101.458)	(100.480)	(110.541)	(91.941)
Selective Index										
Accepted	0.211	0.171	0.446	0.240	0.701	0.236	0.510	0.605	0.790	0.203
	(0.138)	(0.214)	(0.374)	(0.299)	(0.392)	(0.240)	(0.375)	(0.378)	(0.363)	(0.298)
Rejected	0.267	0.177	0.339	0.243	0.395	0.245	0.320	0.420	0.326	0.198
	(0.249)	(0.198)	(0.314)	(0.242)	(0.360)	(0.252)	(0.301)	(0.342)	(0.307)	(0.256)
Total	0.265	0.176	0.354	0.243	0.417	0.243	0.337	0.445	0.346	0.199
	(0.245)	(0.206)	(0.323)	(0.244)	(0.378)	(0.250)	(0.313)	(0.352)	(0.320)	(0.225)

Table B.5

MEAN AND STANDARD DEVIATIONS, MINORITY, 1974

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	2.791	3.262	2.978	2.908	3.025	2.928	3.021	2.805	3.025	2.997
	(0.620)	(0.340)	(0.468)	(0.495)	(0.534)	(0.610)	(0.494)	(0.485)	(0.579)	(0.526)
Rejected	2.849	2.673	2.686	2.693	2.771	2.608	2.756	2.692	2.671	2.545
	(0.641)	(0.604)	(0.598)	(0.618)	(0.604)	(0.596)	(0.591)	(0.664)	(0.598)	(0.581)
Total	2.840	2.710	2.730	2.712	2.800	2.666	2.786	2.714	2.691	2.633
	(0.636)	(0.607)	(0.589)	(0.611)	(0.600)	(0.610)	(0.586)	(0.634)	(0.600)	(0.596)
Non-Science GPA										
Accepted	3.069	3.216	3.202	3.179	3.260	3.254	3.250	3.170	3.248	3.224
	(0.471)	(0.515)	(0.463)	(0.440)	(0.425)	(0.468)	(0.436)	(0.353)	(0.413)	(0.429)
Rejected	3.064	3.010	2.986	2.990	3.125	2.981	3.046	3.051	3.015	2.885
	(0.462)	(0.497)	(0.455)	(0.493)	(0.444)	(0.468)	(0.433)	(0.490)	(0.403)	(0.460)
Total	3.064	3.026	3.019	3.006	3.140	3.031	3.069	3.074	3.028	2.952
	(0.462)	(0.501)	(0.462)	(0.492)	(0.443)	(0.479)	(0.438)	(0.468)	(0.405)	(0.472)
Verbal MCAT										
Accepted	462.143	439.444	547.405	495.556	493.077	472.059	523.571	520.192	533.333	475.370
	(88.897)	(87.462)	(89.130)	(99.406)	(85.638)	(84.299)	(70.593)	(97.548)	(112.857)	(90.702)
Rejected	482.898	439.508	477.032	461.305	470.926	449.194	487.462	476.386	471.832	440.929
	(103.497)	(87.568)	(98.667)	(95.230)	(108.533)	(101.693)	(102.380)	(106.523)	(91.399)	(91.843)
Total	479.757	439.504	487.682	464.068	473.306	453.307	491.456	484.761	475.280	447.571
	(101.473)	(87.406)	(100.428)	(95.928)	(106.384)	(98.975)	(99.947)	(106.105)	(93.187)	(92.311)
Quantitative MCAT										
Accepted	522.857	532.222	568.924	513.000	579.615	515.588	563.286	543.462	546.667	509.074
	(100.530)	(96.455)	(73.265)	(92.963)	(72.566)	(101.442)	(69.791)	(99.062)	(119.569)	(64.823)
Rejected	541.433	471.288	509.582	497.811	516.991	490.226	520.508	508.841	511.040	471.283
	(105.715)	(93.255)	(101.288)	(105.293)	(109.396)	(102.927)	(104.866)	(110.612)	(99.570)	(89.644)
Total	538.622	475.177	518.563	499.070	523.719	494.788	525.903	515.460	513.037	478.571
	(104.893)	(94.472)	(99.802)	(104.261)	(107.704)	(102.858)	(102.671)	(109.180)	(100.475)	(86.516)
General Information MCAT										
Accepted	464.643	461.667	536.646	484.556	494.231	482.353	510.510	524.808	518.333	467.222
	(89.048)	(70.627)	(73.753)	(70.258)	(73.861)	(86.245)	(74.444)	(89.058)	(88.919)	(76.527)
Rejected	488.631	448.295	483.014	472.149	479.583	460.097	488.528	485.023	476.188	464.823
	(99.776)	(75.406)	(89.378)	(88.636)	(100.000)	(88.943)	(85.310)	(97.220)	(92.718)	(76.450)
Total	485.000	449.149	491.130	473.177	481.157	464.101	490.959	492.629	478.551	465.286
	(98.378)	(75.062)	(89.228)	(83.552)	(97.508)	(88.653)	(84.383)	(96.832)	(92.617)	(76.195)
Science MCAT										
Accepted	491.429	485.000	573.987	529.444	553.077	486.471	562.143	518.846	526.667	495.000
	(94.446)	(92.291)	(67.474)	(85.455)	(82.995)	(95.096)	(79.844)	(91.847)	(99.683)	(76.561)
Rejected	512.898	445.758	490.982	476.908	480.741	460.097	500.102	490.114	497.970	452.699
	(114.478)	(94.600)	(106.330	(105.148)	(111.923)	(95.396)	(106.545)	(110.335)	(92.677)	(97.898)
Total	509.649	448.262	508.644	481.262	488.512	464.841	506.964	495.607	499.579	460.857
	(111.711)	(94.782)	(105.640)	(104.600)	(111.327)	(95.630)	(105.665)	(107.488)	(92.820)	(95.390)
Selective Index										
Accepted	0.222	0.122	0.421	0.202	0.540	0.159	0.452	0.539	0.467	0.151
	(0.243)	(0.227)	(0.357)	(0.147)	(0.383)	(0.115)	(0.331)	(0.384)	(0.309)	(0.182)
Rejected	0.276	0.201	0.306	0.226	0.327	0.239	0.323	0.345	0.329	0.188
	(0.268)	(0.200)	(0.287)	(0.224)	(0.328)	(0.249)	(0.303)	(0.310)	(0.297)	(0.186)
Total	0.267	0.196	0.323	0.224	0.350	0.224	0.338	0.382	0.336	0.181
	(0.265)	(0.202)	(0.301)	(0.219)	(0.340)	(0.232)	(0.306)	(0.333)	(0.298)	(0.185)

Table B.6

MEAN AND STANDARD DEVIATIONS, MINORITY, 1975

	1	2	3	4	5	6	7	8	9	10
Science GPA										
Accepted	2.926	3.289	3.104	3.038	3.025	2.982	3.053	3.110	3.327	3.083
	(0.550)	(0.591)	(0.410)	(0.472)	(0.462)	(0.504)	(0.409)	(0.473)	(0.320)	(0.555)
Rejected	2.711	2.750	2.734	2.075	2.8[illegible]	2.599	2.825	2.755	2.705	2.648
	(0.619)	(0.593)	(0.607)	(0.593)	(0.617)	(0.560)	(0.[illegible]0)	(0.615)	(0.643)	(0.528)
Total	2.737	2.798	2.793	2.730	2.897	2.644	2.856	2.799	2.724	2.70[illegible]
	(0.614)	(0.611)	(0.596)	(0.591)	(0.604)	(0.566)	(0.574)	(0.610)	(0.644)	(0.550)
Non-Science GPA										
Accepted	3.124	3.427	3.285	3.209	3.248	3.148	3.262	3.339	3.337	3.292
	(0.440)	(0.383)	(0.411)	(0.467)	(0.409)	(0.529)	(0.405)	(0.386)	(0.510)	(0.506)
Rejected	3.062	3.093	3.093	3.053	3.116	2.976	3.156	3.108	3.090	2.987
	(0.499)	(0.536)	(0.486)	(0.477)	(0.491)	(0.501)	(0.458)	(0.453)	(0.488)	(0.471)
Total	3.070	3.123	3.123	3.065	3.130	2.998	3.170	3.137	3.098	3.027
	(0.490)	(0.532)	(0.480)	(0.478)	(0.484)	(0.506)	(0.452)	(0.451)	(0.489)	(0.485)
Verbal MCAT										
Accepted	479.375	486.304	535.267	512.885	535.400	448.500	551.379	541.429	557.500	499.615
	(98.634)	(99.284)	(86.602)	(78.098)	(80.957)	(69.606)	(82.093)	(78.496)	(128.420)	(92.227)
Rejected	464.605	448.872	488.017	463.258	478.790	446.168	487.280	491.576	492.273	463.793
	(94.540)	(91.548)	(98.444)	(92.716)	(98.166)	(91.932)	(96.438(	(100.326)	(98.834)	(88.958)
Total	466.423	452.209	495.462	467.612	484.590	446.465	495.653	497.658	494.191	468.450
	(94.982)	(92.677)	(98.114)	(92.984)	(97.920)	(89.212)	(97.043)	(99.204)	(99.837)	(89.967)
Quantitative MCAT										
Accepted	518.750	522.478	580.333	549.385	580.600	496.500	595.000	576.607	562.500	553.077
	(103.136)	(119.796)	(62.240)	(79.815)	(87.706)	(83.934)	(65.988)	(74.267)	(78.899)	(75.685)
Rejected	510.789	487.681	511.758	498.682	528.242	484.927	526.865	522.866	521.136	494.885
	(107.071)	(108.758)	(101.558)	(95.859)	(95.917)	(96.699)	(95.950)	(98.871)	(95.010)	(95.675)
Total	493.568	491.318	522.563	502.402	533.607	486.401	535.766	529.423	522.353	502.500
	(106.432)	(110.154)	(99.571)	(95.654)	(96.262)	(95.000)	(95.340)	(97.738)	(94.589)	(95.196)
General Information MCAT										
Accepted	463.125	469.[illegible]48	498.200	493.269	509.800	447.000	509.605	518.036	580.0[illegible]0	489.231
	(72.621)	(60.665)	(73.304)	(74.616)	(61.313)	(65.903)	(71.112)	(69.149)	(70.475)	(80.507)
Rejected	460.789	450.149	472.830	464.515	473.539	463.832	473.497	483.164	489.167	469.195
	(80.098)	(78.525)	(82.131)	(78.143)	(82.993)	(74.222)	(80.839)	(88.476)	(85.890)	(74.004)
Total	461.077	451.860	476.328	466.615	477.254	461.688	478.221	487.418	491.838	471.800
	(79.087)	(77.197)	(81.260)	(78.199)	(81.681)	(73.235)	(80.491)	(87.038)	(86.639)	(74.972)
Science MCAT										
Accepted	505.312	531.522	559.933	525.385	553.000	512.500	584.655	571.429	570.000	543.077
	(68.273)	(103.468)	(74.912)	(68.312)	(82.966)	(59.460)	(69.382)	(80.936)	(94.692)	(67.647)
Rejected	492.807	458.277	490.312	473.758	496.826	453.613	502.124	498.002	492.045	470.345
	(104.006)	(102.465)	(101.526)	(94.615)	(105.884)	(98.714)	(100.772)	(99.352)	(99.914)	(90.978)
Total	494.346	464.806	501.282	477.528	502.582	461.115	512.905	506.961	494.338	479.800
	(100.277)	(104.466)	(100.990)	(93.876)	(105.020)	(96.507)	(101.095)	(100.147)	(100.305)	(91.498)
Selective Index										
Accepted	0.245	0.228	0.438	0.221	0.622	0.233	0.638	0.606	0.336	0.201
	(0.214)	(0.303)	(0.335)	(0.215)	(0.369)	(0.223)	(0.313)	(0.360)	(0.212)	(0.296)
Rejected	0.234	0.200	0.283	0.231	0.348	0.193	0.301	0.339	0.232	0.217
	(0.210)	(0.206)	(0.268)	(0.223)	(0.325)	(0.184)	(0.279)	(0.313)	(0.305)	(0.233)
Total	0.235	0.202	0.307	0.230	0.376	0.198	0.348	0.372	0.324	0.215
	(0.210)	(0.216)	(0.285)	(0.222)	(0.340)	(0.189)	(0.305)	(0.329)	(0.301)	(0.241)

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